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English Translation

of

BHARATIYA JYOTISH SASTRA

(History of Indian Astronomy)

by

Sankar Balakrishna Dikshit

[Translated by Prof. R. V. Vaidya, M. A. B. T.]

PART I

History of Astronomy during the Vedic and Vedanga periods



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PREFACE

In the remote past, when man first appeared on this planet, heavenly bodies like the sun, the moon and the stars. He would not have failed to notice that these bodies kept moving across the sky. However, centuries must have rolled by before some inquisitive and careful observers could discover that there was some periodicity in the movement of these heavenly bodies and such a rhythmic movement could be utilised to reckon time and to keep a count of the days and the months in the year. This was the beginning of Astronomy, which is one of the earliest sciences ever to be discovered in the history of mankind. When and where exactly this occurred, or it occurred at several places independently of each other, it is difficult to say now, because the early man did not have with him any means of keeping a record of his thoughts and observations. In India, which is one of the oldest civilizations in the world, we get evidence of astronomical observations as early as 4000 B. C. in the verses of the Rig-Veda and in some developed form later in the Yajur-Veda. As early as 1300 B. C. the Hindus developed a luni-solar calendar known as the Vedaṅga Jyotiḥśaśāstra. This was in vogue upto the third century A. D. Thereafter, astronomy in our country took a sharp turn and a new system based on scientific principles called the Siddhantic system came into prominence. This development which continued upto the 12th century A. D. came to a standstill due to continued foreign invasions thereafter. The great epics, the Rāmāyaṇa and the Mahābhārata, contain some astronomical knowledge in a rather rudimentary form. Purāṇas which are works of a later period contain astronomical knowledge in an improved form, apparently due to the influence of the Siddhantic system of Astronomy.

For a country like India, with its culture and civilization dating back to many millennia, it is essential that the achievements of earlier generations in the various fields of knowledge should be carefully unearthed and fully recorded. This history of Astronomy of the ancient and medieval periods of India falls under this category and a thorough study in this field requires to be made. But the difficulties in undertaking such a comprehensive study are enormous in that the information has to be gathered from the vast store of Sanskrit literature extending from the Vedic period upto the present time, and in our literature, the astronomical observations are not recorded in a clear cut language but so to say have

been shrouded in allegorical language and concealed in stories and anecdotes, the full significance of which it is difficult to surmise. One such comprehensive study, perhaps the only one of its kind, has been undertaken by Shri Sankar Balakrishna Dikshit in his treatise in Marathi "Bharatiya Jyotish Sashtacha Prachin Ani Arvachin Itihās" in the year 1896 and this is perhaps the only book recording the history of the Indian Astronomy from the ancient to the modern times. Late Dr. M. N. Saha, F.R.S., while working as Chairman of the Calendar Reform Committee recommended that an English translation of this excellent treatise "Bharatiya Jyotish Sashtacha, a history of Indian Astronomy—ancient and modern" should be published by the Government in order to facilitate Indologists, both Indian and foreign, to carry on research on Indian Astronomy. The work of the translation of this treatise from Marathi to English was gladly undertaken by Prof. R. V. Vaidya, M.A., B.T., a Marathi scholar and Superintendent of Shree Jyoti Observatory, Ujjain and who was also a member of the Calendar Reform Committee. This translation was examined and touched up here and there by Late Prof. P. C. Sen Gupta, M.A., a renowned Professor of Hindu Astronomy of the Calcutta University. With the transfer of the entire work of the Calendar Reform Committee to the India Meteorological Department, it decided to publish this work. The final editing of the book has been done under the supervision of Shri N. C. Labiri, M.A., Officer-in-charge of the Nautical Almanac Unit at the Meteorological Office, Alipore, Calcutta.

The book is rather voluminous and it would take considerable time to publish the whole book in one volume. Hence it has been decided to publish the book in three parts. The present volume which is Part I traces the history of Indian Astronomy in the Vedic and Vedanga period from the ancient times upto 1000 B.C. Attempts are being made to bring out the other two parts comprising of the Siddhanta period and the Modern period as early as possible.

India Meteorological Department,
Lodi Road, New Delhi.
18th April, 1968.

L. S. MATHEW,
Director General of Observatories.

History of Astronomy During the Vedic and Vedanga Periods

PART I

BHARATIYA JYOTISH SASTRA

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TRANSLITERATION

The scheme of transliteration of Sanskrit alphabets into Roman script adopted in this publication is the same as generally followed. The corresponding scripts are given below :

[illegible]

AUTHOR'S PREFACE

The subject matter of this book has been presented in broad outline in the introduction and a detailed idea of the subjects dealt with can be obtained from the table of contents and the subject-index at the end. I do not consider it necessary to dilate here on the utility of the book. If it be asked why the science of astronomy came into being at all, I have nothing more to say than that the science owes its origin to the natural curiosity of man. This science must have attracted the attention of man from times immemorial; in fact, one may safely say that it is the very first science evolved by man. This being so, I do not think that any apology is required for undertaking the survey and discussion of the growth of this science in our country.

The present work has no parallel in Sanskrit literature. Our people are not much inclined to assess the merit of different works in the light of chronological sequence; an author born a couple of centuries ago is, in their eyes, almost on a par with one who flourished a thousand years ago. Again, they are not disposed to trace the history of any science nor have they developed the habit of recording the lives of ordinary men. These appear to be some of the reasons why the like of this book was never produced in the past.

I propose to relate here in brief how the opportunity arose for writing this book. About the Saka year 1802 I began to take interest in the question of the Sāyana Pāṭhaṅga and eventually in Indian astronomy. As I went on dipping into old works I was led to estimate that comparative worth, to determine the chronological order of their compilation and to study the various stages in the growth of astronomy; and I began to feel that a work of this nature would be a welcome addition to our literature. In Saka 1806 a vigorous movement for calendar reform had been launched in this province. As a result of this the DAKṢIṆĀ PRĀISE COMMITTEE of Poona published an advertisement in December 1884 for a book devoted to the consideration of the chaotic condition of our Pāṭhaṅgas in the light of the history of our astronomy. As I had a liking for the proposed subject I was naturally prompted to undertake the work. The prize announced for the work was Rs. 450 and the time limit prescribed for it was the end of the year 1886. But by that time I could not procure the necessary material, particularly the ancient works and it was not possible for me to begin the writing. A request was then made to the DAKṢIṆĀ PRĀISE COMMITTEE to extend the time limit, which was granted. But even then nearly six months passed simply in collecting the necessary information. At last I set my hand to the task of writing in November 1887 and submitted Part I to the Committee in the beginning of 1888. Writing and the search for more material went on *part passu*, though not without impediments. At long last I managed to present the whole work to the Committee in three instalments, by the end of October 1888. The contents of the work would have amounted to 425 printed pages of a book of this size and they included the treatment of many more subjects and in much greater detail than what the Committee had expected of me. The work was approved by the Committee and I received the full prize in 1891. Later I began to think of publishing the book; but how could I undertake such an expensive project? A few days later the proprietors of the Aryabhṣan Press agreed to shoulder the responsibility. By this time, however, an advertisement for a treatise on Pāṭhaṅga was published by the Gaikwad Government, for which a prize of 1000 Gaikwad rupees was announced; accordingly I sent to the Gaikwad Govt. the relevant part of the book

in the beginning of the Saka year 1816, i.e. in 1893 A.D. A number of people had been suggesting to me that the book should be published but to my mind it was not yet complete; some new matter that had come to hand was to be inserted at the proper places and some more was still to be collected. Moreover, I intended to await the decision of the Gaikwad Govt. about the work already submitted.* I came over to Poona in July 1894. Many people urged me to publish the book and therefore, the proprietor of the Aryabhatishan Press, commenced the printing in March 1895. While the book was in press, I went on reading old books not seen before and collecting still more information, as can be seen from the footnotes appearing at several pages of the book.

A part of the matter originally submitted to the Daksina Prize Committee has been abridged and at times even omitted, so that the original volume which covered 425 pages has now been reduced by 40 pages; still, the present work has grown into a volume of 524 pages. This amounts to an addition of 140 pages to the original, not to mention the index which is altogether new.

Our people have not even a faint idea at present about the wealth of astronomical knowledge and astronomical literature in our country. The knowledge of the ordinary man is confined to the names of an astronomer or two like Bhaskara-III and at the most the titles of a few works on astronomy. This work, however, contains an account of a host of astronomers and their works; even the more enumeration of their names covers two long lists at the beginning of the indices. The reader cannot but be astounded to see this marvellous wealth of knowledge, and as he reads the history of the growth of astronomy he will come to realize the great calibre of our ancestors from their extra-ordinary efforts, researches and curiosity and his heart will be overwhelmed with delight.

It is needless to say that being scientific the present work will not be readily intelligible to all and sundry like works of fiction. It cannot, however, be said that every section of the book will be found unintelligible. Supposing the book is divided into sections of eight pages, then every such section contains something or other equally intelligible to all readers. The reader should, therefore, not despair if some passage is found to be abstruse, but should proceed with the reading. I am sure that no reader would be found who is unable to understand even a single page of this work. One reader may understand one subject, another may understand some other. One reader may find a particular part interesting and useful while another may be able to appreciate something else. The headings printed on the left side of the page at several places would give a glimpse into the subjects under discussion. Those headings and the table of contents or a glance at the subject-index at the end will enable the reader to find out any passage or subject that he likes. At some places technical terms have been used and if their meaning is not clear they may be looked up in the index at the end for the page numbers for which their definitions, meanings or explanations can be found. Some of the terms have been explained in my book "Jyotirvidya". I was particularly keen on brevity in order that the volume may not run into great length. This has led to the introduction of lengthy compound words at some places in the book; but these can be easily understood from the context.

* The decision has been recently annulled. My work has been approved and the price awarded to me.

The conclusion will show that several articles have been written in English by scholars of repute. No one had, however, treated the subject in such a comprehensive manner. It is also obvious that it was never before treated from the Indian point of view.

Every statement about the contents of old works made in this book without citing some authority is based on my reading of these works; and I have most of such important works on astronomy in my possession. Every conclusion purporting to be the result of mathematical calculation, has been arrived at from careful calculations personally made by me and I am sure that they are correct; still as it is human to err, some errors might have crept in through oversight. In certain cases the necessary works were not available to me for reading and I had to rely on their authors and works while writing about their contents; in all such cases I have cited the authority for my statements at the proper places. Again, where extracts have been taken from other books bodily or in a summarized form I have cited chapter and verse for every quotation. Except for this, not a single line of this book is based or borrowed from any other book or its translation.

Members of the Dakshina Prize Committee had made a few suggestions to me for the improvement of the original work. All of them except the one for abridgement have been carried out. At some places in the original work I had severely criticized European scholars. The Committee suggested that all such severity should be entirely dispensed with. Accordingly, I have toned down all such passages, though I have maintained the main points of criticism. I cannot, however, help observing here that even some of our eminent scholars look upon the verdict of Europeans as gospel truth, however absurd it may be. This induces lack of confidence in one's capability and scholarship.

Rao Bahadur M. G. Rande suggested that controversial matters like the views of European scholars and my criticism of them should be expunged from this book and reserved for discussion in some English journals, so that the book may not become voluminous. Accordingly, I did discuss some of the questions in English journals; still I did not feel it proper to remove the relevant portions from this book. It will be found useful by some readers at least if not all. If fortunately, this work is translated into English, this detailed exposition of my views will come to the notice of European scholars and receive proper consideration from them. A European scholar has written to me that parts of this work will have to be specially translated, if an English translation of the whole is not soon forthcoming.

I want to urge my readers in all earnestness to keep a sharp look out for ancient works. I shall feel highly grateful and equally so, our country, if any one informs me of the discovery of some works not yet seen by me. Not much account could be given in this book in respect of works compiled in such regions as Telangana, East and Bengal. It is desirable that people should get as much information as possible about the more importance of such works as also about works like *Madhyamaka*. Again, the descendants of many of the authors mentioned in these pages might be still living; and if they impart some more information to me it will no doubt, prove useful.

As regards publicity of old works, it has been noticed that the Telangana and Dravidian works are not widely known in other provinces. This seems to be due to the difference of script in which they are written. The works produced in Bengal

are also not available in this province. Even then, looking to the difficulties of travel and communication in ancient times, one is really surprised to see how voluminous works could reach even the remote corners of India, how works like *Grakalaghava*, so frequently mentioned in this book, gained currency all over the country in a very short period of time, and how even mediocre works have been popularised. This wide-spread currency of books seems to be due to the fact that astronomers used to be patronised not only by Hindu Kings but also by Muslim Emperors. Moreover, it appears that most of them could count upon liberal reception from the Vidyapiths (Academy) at Varanasi.

It is true that the number of works on astronomy is enormous. As however ours is a very extensive country, a multiple of works devoted to the same subject of every day use were compiled in different provinces. Again, some works, specially the *Karasa* works, became obsolete and useless in course of time, which also gave rise to different works in different ages; further, several people appear to have compiled several works on the same subject because it depends more or less on the ingenuity of the author or whether his work would be found to be perspicuous or not. These are some of the reasons for the multiplicity of astronomical works and their wide-spread currency.

The Vedic *mantras* or Sanskrit verses have been frequently quoted in this book. If a full translation of all these is given, it would mean an increase in size. It has, therefore, been given, not in all cases but only where it was very necessary to do so. At some places only a gist of the quotations is given, and at places where even that is not given, it can be gathered from the context to a certain extent. In giving the meaning of Vedic *mantras*, the original text has been followed. Words that must be taken as understood for proper construction of the passage have been given in square brackets and equivalents of words or phrases in parentheses. Nothing has been added that is not in the original. The printing of Vedic *mantras* or Sanskrit verses is faultless on the whole. It was, however, impossible for me personally to write out the whole press copy. Consequently some errors might still have remained, if these were not noticed while correcting proofs; but I could not help it.

Biographical sketches of astronomers have been given in the *Madhyamadhikara* (Chapter on mean motions); these mainly deal with authors who compiled works on astronomy. If any of them happen to be compilers also of works on *Samhita* and *Jataka*, such works have been taken into account at the same place. As for the authors who have compiled no astronomical works but only works on *Samhita* or *Jataka*, their lives have been given in the sections devoted to these *Skandhas* (branches).

The life of each astronomer, as a rule, contains information on mostly the following points — his date, place, works compiled, commentaries on the works and an estimate of his capabilities. If any of his ancestors or descendants also happened to be authors, they are also taken into account. In addition to this, the remarks above features of his life work, if any, has been mentioned in the contents. The contents give a list of works or their authors along with the date year which indicates the year of composition. ~~where the words which have been added.~~

This translation could not be scrupulously observed in the English translation. —

I am of opinion that the 'anusvāra' (a dot denoting the nasal sound) need not be added to the last letters of the words 'jetha', 'tetha', 'kotha' etc. and I also hold some independent views on the question of orthography. My views have been followed in certain cases; but the copyists, proof correctors and even the compositors have become so very familiar with the rule of the terminal dot, that the 'anusvāra' have found their way into this book, even though eliminated in the press copy.

It is my opinion that the names of ancient authors should not be mentioned in the honorific plural and this rule has been generally observed. As even the Almighty is spoken of in the singular, I do not think that the plural form e.g., 'Bhaskarācārya Mhanat' implies any greater respect for the author. It can safely be said that there is no honorific plural either in Sanskrit or even in English. It is at present customary, however, to use the plural form while speaking of certain personages living or recently deceased. I have generally retained only this, lest a breach of the formality should jar on the ears of my readers.

As we are these days more familiar with the Christian era than the Saka era, it is more convenient to discuss the dates of events in terms of Christian era. Our astronomical works, however, invariably use the Saka era. Let the work belong to any part of India whatsoever, it is bound to use the Saka year, even if it is not in use in every day life there. I have accordingly used the Saka era almost everywhere in the book. However, the year indicated as B. S. (before Saka) can safely pass for B. C., because the difference of 78 years is negligible where dates of very remote antiquity are concerned. Everywhere in this book the Saka figure indicates the expired year unless it is specifically stated to be current. The planetary positions should be taken as *Nirayana* or as calculated by the *Grahajyotiḥ* system unless the word *Sayana* is specifically used. Words like *Surya-Siddhanta*, *Ārya-Siddhanta*, and *Brahma-Siddhanta* used without qualification, should be taken to mean the current or later *Surya-Siddhanta*, the first *Ārya-Siddhanta* and the *Brahmagupta-Siddhanta* respectively.

It goes without saying that the index is very convenient for the purpose of reference. But experience alone can show how difficult it is to prepare an index. As it would have a long time to prepare it single handed, I have myself prepared only the subject index. In preparing the remaining indices I received considerable help from the present students of the Poona Training College. But as the work has passed through many hands and the lists were copied out five times before their final printing, some errors of omission and commission may have crept in at places; but no one could help it. It is the practice of our writers to include their works on Arithmetic and Algebra among those on astronomy and the practice has been adopted in preparing the index; similarly, the names of almanacs, Sanskrit and Marathi works and their authors have been included in the Sanskrit list. The letter T (denoting Tip or footnote) has been left out at places before the page numbers in the index.

It would be difficult for the readers fully to realise what pains were taken to procure old works while writing this book, what people were coaxed and cajoled and in what way, how speedily the work of reading was done, and what mental and physical strain I had to undergo on the whole, while writing the present work and getting it printed. The pleasure of the pursuit was the only true reward of these labours.

The sale of the book is bound to be poor because it is scientific and of course I could not have shouldered the expensive and risky work of printing. But Mr. Hari Narayan Gokhale, a proprietor of the Aryabhushan Press, Poona, who is my former playmate and a fellow townman undertook the work and completed it with success. He has thus obliged me as well as the whole of Maharashtra. If he had not been pressing me to get the book printed and continued to press me to finish it soon while the printing was in progress, it would never have seen the light of the day, for it would never have really reached completion to my satisfaction till the end of my life. Had the whole manuscript been ready at the outset, the publisher would have printed it within two months; but the publication was so long delayed, because my reading went on ceaselessly at the same time. The publication of a work of this kind must inevitably take a long time. Still, whatever work could be accomplished so far, has been brought to completion as far as possible. I shall feel much obliged if any defects found in this work are brought to my notice or suggestions made in regard to its contents.

I have received help from several people in several ways from the day I started writing till this day of publication. Even if I merely mention their names and the kind of help offered it would easily cover a page or two; instead of doing this I wish to express my gratitude to all of them most sincerely even though in a general way.

It was a convention with the ancient writers on astronomy to give a brief account of themselves. I could write the major portion of the book because of this convention. Now I propose to follow suit and give a brief account of myself before I conclude the preface; I was born on Tuesday, the 14th-cum-15th lunar day (tithi) of the bright half of Ashadha, Saka 1775 (according to Grhasarghava Panāṅga) i.e. on 20/21 July 1853, at the village of Murud, in Dapoli Taluk, District Ratnagiri, my birth ascendant being Gemini. My ancestral line from father backwards runs thus; Balakrishna, Ramachandra, Ballala and Shankar, and my mother's name was Durga. I am a Chitpavna Brahmana of Nityundam-pavana. This family has inherited the priesthood and religious leadership of the village of Murud which was founded by a saint some centuries ago; our original ancestor was his disciple and this vocation was conferred on him by the saint. About two years of my childhood were spent in elementary education at the village school and later in a local Government Marathi school, from April 1863 to October 1868. These very years were partly devoted to some study of Sanskrit and reciting of the *Vedas*. Part of the next two years passed in working as a candidate at Dapoli Court and a part in learning English. I was a student in the Poona Training College for three years from November 1870, when I obtained a first class certificate in the final examination of the third year. While studying at the Training College, I attended an English school one hour every day for two years. In 1874 I passed the Matriculation Examination, but I could not join College owing to several difficulties. I worked as the Head Master of the Marathi School at Revadanda from February 1874 to February 1880, and later on as Head Master of the Marathi School No. 1 at Thana up to August 1882. Afterwards I worked as an Assistant teacher at the English school at Barai till the end of October 1889 and as an Assistant at the Dhulia Training School till the end of June 1894. Since then, I have been working as an Assistant Teacher at the Poona Training College. I wrote and published the following Marathi books in the years noted against them:

the sun vanishes. Then follows the darkness which continues for a long time. Next day, the sun rises again almost at the same point and not in any direction at random. The observer then wonders, "Is it yesterday's sun which has risen today or is there a new sun rising every day? If it be the same sun where did it dwell at night? Why does it not rise in any direction at random? Why are its hot rays vary in intensity? The sky appears to touch the horizon at the place where the sun rises; then how it is that the sun comes above out of that very place? If there be an ocean in the east and an ocean in the west, the sun appears to be emerging from one and plunging into the other; does it really sink in the ocean?" We do not attach any importance to such thoughts today; but in the beginning human mind must have been haunted by these thoughts and much time must have elapsed before any of these problems could have been finally solved. The knowledge of human being grows by tradition and the experience of the past and this proves useful to the posterity. Even in modern times, year after year rolls by till we come across a new discovery, which might eventually seem to be trivial but at the time of its invention it is taken as an established truth.

It is then obvious that at the beginning of civilization considerable time must have elapsed before the truth about even the most common place experiences came to be definitely known.

The questions above about the sun as having disturbed the primitive mind is not merely a figment of fancy. Evidence of such primitive thought is found in the Jain literature which shows that the Jains believed in the existence of two suns. The Purāṇas too have postulated twelve different suns for the twelve months of the year. The twelve *Adityas* of the Vedic literature are also well known. Although these notions appear today to be fantastic, it is clear that there was a time when people really cherished such beliefs. For instance the following verse from the R̥gveda would show that the sun was supposed to have actually sunk itself in ocean before rising the next day.

अग्नौ सूर्यं वायुमग्निं सूर्यं ॥ अग्नौ सूर्यं वायुमग्निं सूर्यं ॥

ऋ. सं. १०. ७२. ७.

"Oh gods! you draw out the sun (for the purpose of rising up again in the morning) which was sunk in the ocean."

The following *mantra* from *Taittiriya Brāhmaṇa* may similarly be cited :

अ वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं ॥

अग्नौ सूर्यं वायुमग्निं सूर्यं ॥

"May the resplendant sun, that comes up from the centre of the expanse of water of the vast ocean, purify me."

The sun rises in the morning. It reaches the highest point at noon and sets in the evening. As if it crosses the whole sky in three strides. This phenomenon has been described at various places in the Vedic literature. That the sun transfers its heat and puts it into *Agni* (fire) at night is also described at many places.

अ वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं वायुमग्निं ॥

अग्नौ सूर्यं वायुमग्निं सूर्यं ॥

"The sun enters *Agni* in the evening. Hence *Agni* is visible at night even from a distance."

In this verse the sun is said to be entering *Agni* at night. The primitive man's attention must have been drawn to the moon just as much as to the sun or even more. Unlike the sun, the moon does not rise regularly at night. Sometimes when it rises at sunset the moon appears full in size, and then, a days pass on the moon rises later and later every day and gradually grows smaller in size. It also rapidly changes its position among the stars.

It slowly approaches the sun and a day comes when it becomes completely invisible and then after a day or two, the moon makes its appearance in the west after sunset on the other side of the sun; but at that time, it appears only in the form of a crescent, as if it were newly born. It is well known that on this day even now we find that people joyfully offer her the trills of their garments and pray to her for new garments and long life, chanting all the while the following *Mantra* which is found in all the four Vedas.

॥ अथ श्रीमद्भगवत्पूजाविधिः ॥

॥ : ॥

1948. 10. 24. 1948.

The moon gradually increases in size as days pass and again becomes full some day. Many descriptions of the moon's waxing and waning are found in ancient and modern works. And what is more, the digits of the moon, the dark spots on her face, her soft and serene appearance and her refreshing light, have provided an outstanding theme for poetic imagination in all countries at all times.

The moon becomes full after 29 or 30 days, and it becomes full again and again after the same number of days. The primitive man must have adopted the day (i.e. a day and night together) as the natural unit of time, after observing that the period between two successive sunrises is almost the same. Similarly, after observing the rule about the full moon stated above, he must have adopted the period between the consecutive full moons as the second but a longer unit of measuring time. This period seems to have received the same term as that given to the moon in many languages. In the Vedic literature, the moon is named as *māsa*. As an example the following lines may be seen :—

Rk Samhita and Atharva Samhita—

[illegible]

—Rk Samhita—

१७७७ ई. १०. २३. २४.

That the name *masa* originally given to the moon was later applied to the above mentioned period is well known.

After these two units, the day and the month, were firmly established, man must have observed that the rains, winter and summer recur after some definite period of time. It was also observed that the rains and other seasons recur after twelve months, where a 'month' denotes the period indicated by the full-moons. This (long) period of twelve months appears to have been called in the Vedas—*Sarad*, *Hemantia* etc. after the seasons in the *Rk Samhitā*. The term *Sarad* in the sense of a year, occurs there more than twenty times and the term *Hima* more than ten times. These words are found in many places in other parts of the *Rigveda* as well. The very word *Varṣa* meaning 'a year' also signifies a particular season.

सम्यक्कालं वर्षाः सप्तैश्वर्यवर्षाः ॥

ऋ. १०. १११. ४. अथ. १. २०. २३. ६.

"Do live and grow for a hundred autumns (i. e. years), for a hundred winters and for a hundred springs."—*Rk Samhitā and Atharva Samhitā*.
The words *Sarad*, *Hemantia* and *Vasanta* all meaning a year occur together in the above verse. Even the term *Samvatsara* is very often found to have been used in the sense of a 'year'.

Any way the year is the third natural unit of time, but longer than the day and the month. So far we have had a glimpse of the origin of the three units of time. An attempt to describe in detail the gradual development of the basic astronomical concepts would involve a long exposition. This however is not necessary at this stage. The main features of this development are going to be described in detail later on.

Just as the observation of the sun and other heavenly bodies creates a sense of wonder, even so their regularity and other characteristics strike one as most surprising and inspire a feeling of reverence for them. It is but natural that one should be led to infer that these celestial phenomena are controlled by some eternal truth and that the magnitude of that truth is simply too great to be described. The following verses from *Rigveda* are worthy of note in this context :—

सम्यक्कालं वर्षाः सप्तैश्वर्यवर्षाः ॥

सम्यक्कालं वर्षाः सप्तैश्वर्यवर्षाः ॥

ऋ. १०. १११. ४. अथ. १. २०. २३. ६.

"The transcendental truth supports the universe, the sun is supporting the sky; the twelve suns remain supported by truth and so remain the moon in the sky."—*Rk Samhitā and Atharva Samhitā*.

Even today we hear many people remark that all have discarded truth in this sinful *Kaliyuga*, but the sun and the moon have not.

Some celestial phenomena are joyful to watch, some are amazing while some others are even frightening. When the eclipses, shooting stars and

comets inspire a sense of awe and even fear in many a mind even in the present times, it is quite obvious that in the beginning these phenomena would have been regarded by the human being as extremely frightful and portentous of divine wrath. Many of us must have read how Christopher Columbus told the inhabitants of an island that because the god Sun was displeased with them he would hide himself on a particular day and how those people were frightened to see the prediction come true. Again it is a historical fact that the war, which had continued for five years between the people of Lydia and Media, about the year 584 B.C., came to an end by the mutual signing of a peace pact, because a total solar eclipse had occurred during the year and both the fighting parties were struck with horror to see the day suddenly turning into night.

It is also known to many of us that the *Mahābhārata* gives a description of how the two eclipses of the sun and the moon had occurred in the same month just before the terrific battle between the Kauravas and Pāṇḍavas was fought resulting in a tremendous loss of life. Similarly, in the Purgas we come across descriptions of shooting stars and meteors and appearances of comets preceding such calamities.

The natural units of reckoning time, i.e., the day, the month and the year which guide human activities, depend upon celestial phenomena. The knowledge about seasons which is necessary for agriculture depends upon the sun. That the rains are caused by the sun and the tides by the moon, and that it being felt that the wrath of Almighty is foreshadowed by some particular positions of the heavenly bodies, tend to show that curiosity must have aroused in human mind towards astronomical knowledge right from the creation of the human race. Again, certain ideas must have planted themselves in the human mind from very ancient times; for instance, it might have been thought that since agriculture and other vocations of life are carried on when the sun and the moon occupy certain positions in the sky, it is quite possible that they would have been thought to prove beneficial when performed while the luminaries are in a typical position; as for example, the fields may yield a bumper crop if the seed is sown when the moon is conjoined with a particular star and on the other hand crops are destroyed if sown when it is conjoined with another particular star; some religious rites if performed when the sun turns from south to north or *vice versa* (that is on solstitial days) give beneficial or harmful results as the case may be. If marriages and such other rites are performed at certain auspicious moments they turn out to be beneficial; when two planets were observed as passing very close to each other in the sky, they came to be interpreted as 'fighting with each other' and then one of them (the fainter of the two in luminosity) was regarded as having been defeated and this fight was supposed to be indicative of victory or defeat of a certain king on the earth; it was also surmised as to what particular rites, if performed would nullify the malefic effects indicated by the appearance of eclipses, meteors or comets. Furthermore, it was but natural that ideas and convictions should have gradually begun to crop up in human mind that if the heavenly bodies have such a close association with the worldly affairs and their good or evil results, they must be affecting the individual life as well and then the people must have attempted to foretell what benefic or malefic effects would be experienced by any individual in his life, because the sun, the moon and the planets were occupying certain positions in the sky at the time of his birth and would be subsequently occupying other positions.

The quest of knowledge regarding such matters led to the creation of three branches. The following questions, for instance, are associated with Mathematics (Ganita) : Finding out the number of days in a month, the number of months in a year and the number of days in a year ; when will the winter solstice or the summer solstice occur after a particular day ; what position in the sky will a particular planet be occupying on a certain day ; when will an eclipse take place, and so on. These questions are related to Mathematics. The knowledge of the effects of eclipses, comets, planetary conflicts on the world and the knowledge as to what days are auspicious or otherwise for the performance of marriages and other rites—these questions form the second branch ; and the third branch comprises the knowledge which enables one to judge the benefic or malefic effects that would be produced by a particular position of planets at birth or later on in the life of an individual. These are said to be the 'Three Branches' (*Triskandha*) of astronomy.

All the ancient and modern works in astronomy hold that the science is divided into these three branches. The first is called *Ganita*, the second *Samhita*, and the third *Hora* or *Jataka*. The *Ganita* branch is also known as *Siddhanta*.

Narada observes :

त्रिबन्धोऽस्त्रोन्मेषः । तस्य त्रयं ब्रह्मविद्याः शतैकमेव ॥

मित्राक्षर. १. ४.

"The excellent science of astronomy comprising Siddhanta, Samhita and Hora as its three branches (Sections) is the clear 'eye' of the Vedas". —*Narada Samhita* I. 4.

Mahadeva (Saka 1185), the commentator of Sripati's *Ratnamala* says:—

अष्टविधा विद्याः सन्ति ज्ञानाः । तेषां त्रयं ब्रह्मविद्याः शतैकमेव ॥
अष्टविधा विद्याः सन्ति ज्ञानाः । तेषां त्रयं ब्रह्मविद्याः शतैकमेव ॥

"I am desirous of describing in brief, the interpretation of Samhita rules which are necessary to be followed, while performing ceremonies relating to post-natal sacrament, naming the child, thread ceremony, marriage, travelling, etc., knowing fully well that Samhitas are 'fruits' of the tree of astronomy, of which the various forms of Hora are the 'branches' and elementary arithmetic, algebra and calculation of planetary places are the firm 'roots'."

Ganeta Daivajña observes (about Saka 1440) in his commentary on *Muhurta Tarva* of Kesava.

अष्टविधा विद्याः सन्ति ज्ञानाः । तेषां त्रयं ब्रह्मविद्याः शतैकमेव ॥
"Sri Kesava, having expounded.....the *Ganita* branch and.....*Jataka* branch declares before proceeding to.....the *Samhita* branch."

The attention of our people was drawn to the study of celestial bodies from very ancient times; still considerable time must necessarily elapse before any subject can evolve itself into a science. Similarly, a long time must have elapsed before the standard works on the subject of astronomy could be written, and it is obvious that the works which were written in the beginning of the evolution of the subject must have contained simple statements of facts of an elementary nature and those too of only broad outlines. The most ancient of the astronomical works extant in these days is the *Vedāṅga Jyotiṣa*. It deals with the mathematical aspect of only the sun and the moon; the *Ātharva Vedāṅga Jyotiṣa* may be a later work*. This deals with some aspects of the second and the third branches of astronomy.

It seems as if the *Samhitās* of Garga and Parāśara belong to a later age. After the knowledge of astronomy had considerably developed it must have been grouped into three divisions or branches including *Gaṇita*. But this stage must have been preceded by certain works in which all the branches were discussed together. It appears that works of this type did exist and they too were known by the name *Samhitā*. Varāhamihira says in his *Brhat Samhitā* :—

वर्तितः सत्तत्त्वज्ञानेन सत्तत्त्वज्ञानेन सत्तत्त्वज्ञानेन ॥

वर्तितः सत्तत्त्वज्ञानेन सत्तत्त्वज्ञानेन सत्तत्त्वज्ञानेन ॥

"The science of astronomy which comprises a variety of subjects is established mainly on three branches. But the treatment of the subject in its entirety is also named *Samhitā* by the sages."

We have no clue for ascertaining whether there were any works more ancient than the *Vedāṅga Jyotiṣa* and the *Samhitās* of Garga and others. None of these are available at present. Nor can we say with any degree of certainty whether the *Samhitās* of Garga and others that are available at present, have all retained their original composition and structure. In the case of *Garga Samhitā* some two or three versions are available. Nevertheless, it is evident that some *Samhitā* works containing a treatment of all the three branches together must have been in existence at one time, as is evident from the above quotation from Varāhamihira, let alone be the question whether such treatment was complete in itself or only fragmentary. As the knowledge of astronomy was progressing and as each branch was nearing perfection, different works, each devoted to some specific branch, came to be written and the term *Samhitā* was then exclusively applied to one branch in particular. Varāhamihira's *Pañcasiddhāntikā* shows that there were independent works on the different branches written before his time (i.e., before Saka year 427). Aryabhata's work, which deals exclusively with *Gaṇita*, belongs to a slightly earlier date than that of Varāhamihira. It will, however, be shown in detail, in the following pages, that the *Gaṇita* branch had become independent at a still earlier date. As for Varāhamihira himself, he has to his credit independent treatises on all the three branches.

Let us now enumerate the subjects commonly found in the works on each branch. The mathematical branch consists of three sections

*Many subjects have been mentioned here only very briefly in order to give a general idea of later works; their detailed survey will be made at appropriate places.

[illegible]

“The wise people describe the *Ganita Skandha* (i.e. the branch of mathematical astronomy) as that work, which gives in detail all the units of time from *Truti* (moment) to *Pralaya* (Universal deluge) and deals with the motions of planets, and which treats of mathematics in the form of questions and answers. It is mainly divided into two parts. It also describes the position of the earth, the stars, the planets and also the instruments for observation.”—*Siddhanta Sironani, Madhyamādhikāra.*

In the Siddhanta work the beginning of the *Kalpa* is taken to be the epoch; in the Tantra the epoch is the beginning of a *Mahayuga*, and in the Karaṇa any Saka year can be the epoch, and the calculations of planets' places are made on the basis of the respective epochs. As a matter of fact there is no difference between them in regard to the computation of planetary positions excepting that each adopts a different epoch. The part of the work devoted to planetary calculations in all the three varieties contains a number of chapters called *Adhyāya* or *Adhikāra*. In general, the chapters are as follows:—

- It is not the fact that all works contain the same number of chapters, as above. Although there are variations in the number and order of chapters, yet all of them have been included in the above list of eleven chapters.

There is no unanimity of opinion regarding the subject matter of the *Sāhita* branch. In general, the *Sāhita* may be regarded as divided into two parts. The first deals with the movement of planets in the Zodiac and their mutual conflicts, etc., the consideration of benefic or malefic effects of meteors, comets, eclipses and omens on the world. The second is devoted to the selection or consideration of auspicious moments or otherwise, for starting on a journey, the celebration of a marriage etc. Varāhamihira's works show that in his time both the branches enjoyed equal importance, but from Śrīpati's time, that is from Saka 960, the first part began to lose its importance and from about Saka 1450, the second part gained so much importance that only the chapter on *muhūrta* began to pass for the third branch. This can be confirmed from the titles and the subject matter of the following works:—*Muhūrta Tattva*, *Muhūrta*, *Māraṇḍa*, *Muhūrta Cintāmaṇi*, *Muhūrta Cudāmaṇi*, *Muhūrta Dipaka*, *Muhūrta Gaṇapāṭi* and others. The works on *Muhūrta* do contain some of the subjects described by Varāhamihira in his *Brhat Sāhita* but not with any degree of importance.

The *Hora* branch originally represented the study of the ascendant of birth in one's horoscope, and the prediction of all the happy and sorrowful events of life; but afterwards it was divided into two parts, the above mentioned part being one of them. In the beginning, the complete *Hora* section was known as *Jāṭaka*, but later on this particular part relating to the ascendant came to be known as *Jāṭaka* and the second part as *Tājik*. The principal subject of *Tājik* generally is the study of events, good or evil, in any individual life, from the ascendant of the annual horoscope which is cast for the moment of his entry into any new year of his age reckoned on solar basis. Under this system of horoscope reading, the radical ascendant is regarded as a planet and is known by the name *Mūlāṇḍa* (Mūlāṇḍa?). Some authors have coined the Sanskrit term *Tārīyaka* for *Tājik*. This part of *Hora*, viz., *Tājik* came into vogue from about Saka 1200, that is by about the time of increasing Muslim domination in our country.

In the books on astronomy in this country, the chapter which generally deals with such problems as positions of the sun, the moon, the earth, etc. in the universe, the causes of their motions and the nature of such motion is known as *Bhuvana Saṁsthā*, *Jagat Saṁsthā*, *Bhuvana Kōśa* or by some other equivalent names. These three subjects will be discussed in detail later on at the proper place; but to introduce the subject, the celestial sphere, the motions of planets, the movement of the solstitial points, and the *Yuga* system of measuring time are briefly described below.

BHUVANA SAMSTHA (The Celestial Sphere)

According to our astronomical works the earth is at the centre of the Universe; the moon and other bodies revolve around it; their order is, the Moon, Mercury, Venus, the Sun, Mars, Jupiter, Saturn, and the starry belt; the Zodiac revolves round the axis joining the two fixed poles. The earth is round, it stands supportless and is enveloped by air which is called *dhāvay* or earthy-air. Above this is the sky, where blows the wind called *pravaha* by the force of which the moon and other heavenly bodies are kept in

motion, and they revolve round the earth. This description is found in all *Siddhanta* works and *Tantras*, but not in *Karana*-works. It is also found in the *Pāñca-Siddhantikā*. In no man-made or written works on astronomy do we find any expression of views more ancient than those found in the *Pāñca-Siddhantikā* and hence the lines presenting the above ideas are quoted below :

पञ्चसिद्धान्तमन्त्रादिप्रमाणैः ॥

सूर्यादिग्रहः सूर्येण चक्रेण चक्रेण चक्रेण ॥ ११ ॥

पृथ्वीः सूर्यादिग्रहस्योत्पत्तिः सूर्यादिग्रहस्योत्पत्तिः ॥

तत्र सूर्यादिग्रहस्योत्पत्तिः सूर्यादिग्रहस्योत्पत्तिः ॥ १२ ॥

सूर्यादिग्रहस्योत्पत्तिः सूर्यादिग्रहस्योत्पत्तिः ॥ १३ ॥

सूर्यादिग्रहस्योत्पत्तिः सूर्यादिग्रहस्योत्पत्तिः ॥

"The round ball of the earth, composed of the five elements, abides in space in the midst of the starry sphere, like a piece of iron suspended between magnets. 1. Straight above *meru* in space one pole is seen; the other pole is seen below, placed in space. Fastened to the poles the sphere of the stars is driven round by the *pravaṇa* wind. 5. Above the moon there are Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, and then the stars. 39."

—*Trailokyā Samsthāna, Chapter 13.*

The starry belt, along with planets, appears to make one complete revolution round the earth in about one day. But it was only Aryabhata I, who held the modern view that this diurnal motion is not real but apparent and is caused by the diurnal rotation of the earth; others held that the diurnal motion of the starry belt was real and almost all the authors of *Siddhāntas* have blamed Aryabhata for holding a divergent view.

The planets appear to move from west to east with respect to the stars and in the science of astronomy this kind of planetary motions have principally to be dealt with. The *Sūrya-Siddhānta* has explained this eastward motion of planets as follows :—

पञ्चसिद्धान्तमन्त्रादिप्रमाणैः सूर्यः सूर्यः ॥ ११ ॥

पञ्चसिद्धान्तमन्त्रादिप्रमाणैः

"The planets being overtaken by the stars moving with greater speed in their westward motion, fall behind equal distances in their orbits (and hence they get an eastward motion)"—*Mādhyaṃadādhikāra-25.*

In substance, this means that the diurnal motions of planets being less than those of the stars, the planets lag behind and hence they appear to move eastward with respect to the stars.

Aryabhata I had already taken it for granted that the diurnal motion of the stars was not real and hence it was not necessary for him to make any assumption like the above to explain the eastward motion of the planets. He had already assumed a real eastward motion for them.

Another kind of assumption which has been made about the motion of planets is that their eastward motions in their orbits are equal. But the distances of planets from the earth being unequal, the orbits of farther planets are wider than those of the nearer ones; and that is the reason why we notice difference in their eastward motions. The moon being nearest to the earth has the swiftest motion and Saturn being the farthest of all planets, its motion is the slowest. The *Pañca-Siddhāntikā* says:—

स्मृतमस्मिन्मार्गेऽस्मिन् सूर्योऽस्मिन् सूर्योऽस्मिन् ॥३९॥
 पृथिवी सूर्योऽस्मिन् सूर्योऽस्मिन् सूर्योऽस्मिन् ॥४०॥
 अस्मिन्मार्गेऽस्मिन् सूर्योऽस्मिन् सूर्योऽस्मिन् ॥४१॥
 अ० १३ अस्मिन्मार्गेऽस्मिन्

"All planets move towards the east with the same velocity each in its own orbit. 39. The moon which is placed (lowest) below the sphere of the stars revolves quickly in its small orbit; Saturn which is placed highest above revolves slowly in its large orbit with the same velocity."—
Trailokya Samsthāna, Chap. 13.

One complete revolution of a planet in the zodiac is called *bhagāna*. It is obvious that the time for one *bhagāna* must have been determined after observing the times taken by the planet in making several revolutions. The astro-mathematical works give the number of *bhagānas* which each planet completes in the period of one *Kalpa* or one *Mahāyuga*. The motion of a planet as calculated from these periods using the *bhagānas* mentioned by the *Pañca-Siddhāntikā* must be the same for every day. This is called the 'mean motion'. But the motion of a planet as actually seen in the sky is not always the same. For instance, Jupiter takes about twelve years for one revolution and hence its mean daily motion comes to be about 5'; but the actual observation of the planet shows that Jupiter sometimes moves faster than that and sometimes slower; its daily motion is sometimes found to be as much as 15' and sometimes it is slower than even 1'; not only this but sometimes the planet also appears even to move in a reverse direction i. e. from east to west (this is called retrograde motion). The planet's daily motion as is actually seen is termed 'true or apparent' motion; similarly the planet is actually found to be somewhat ahead of or behind the position calculated from its mean motion. The real position of a planet is called its 'true place' and that found by adopting the mean motion is called its 'mean place'.

To find the true place of a planet at a given moment, which in other words is to find where the planet will be observable in the sky at a particular time, is the main subject of the mathematical branch of astronomy.

THE AYANA CALANA

(The shifting of the solstitial points)

The period that elapses between two successive 'conjunctions' of the sun with a particular star is termed *Nākṣatra saura varṣa* or 'Sideral Solar year'. The two points of intersection of the ecliptic and the equator are called *Sampāta* or *Kṛāntipāta* (i.e. equinoxes). The equinox from which the sun enters into the northern side of the equator and which marks the spring season is known as *Mesa* or *Vasanta Sampāta*, that is, the vernal equinox.

Let us suppose that at some time there is a star coinciding with this equinoctial point and that when the sun comes to that point the year commences. The equinox has got a motion, and it recedes back at the rate of 50" per year. On account of this, the stellar zodiac appears to be moving to the east by an equal arc. The time taken by the sun to return to the same equinox is termed as *Sāṃpādik Saura* (i.e., tropical) year. This is also called the *ārtava* (seasonal), and the *śayana* year. When the sun would return to the same equinox it would, as it were, find the above-mentioned fixed star still 50" ahead, and it would require about 50 *pālas* (twenty minutes) more to arrive at the star. Hence, the sideral year is found to be longer than the tropical year by about 50 *pālas*. The seasons depend upon the tropical year. If there is a particular season when the sun comes to an equinox, the same season would recur every time the sun returns to the same equinox again; on the other hand, it is evident that the same season would not be found recurring at every conjunction of the sun with a star. If one point of the orbit shifts its position every other point also does so. As the equinoctial point recedes, the solstitial points also fall back; hence if the winter solstice is found to occur when the sun is near a particular star, the future solstitial transits will be found occurring gradually further westward from that star. The motion of the solstitial points which is the same as that of the equinoctial points was first detected from the westward position of the sun with respect to stars at the time of successive solstices. Hence, this motion is termed as *Ayana Calana* or the shifting of the solstitial points.

THE YUGA SYSTEM OF MEASURING TIME

The measure (length) of the *Kaliyuga* is 4,32,000 years. Those of *Dvāpara*, *Treta* and *Kṛta* are respectively twice, thrice and four times of this. These four *yugas* constitute the *Mahāyuga* and its measure is ten times that of the *Kaliyuga* and is equal to 43,20,000 years. One thousand such *Mahāyugas* make one *Kalpa*, which is known as *Brahma's* day. The *Kalpa* contains 14 *Manus*. So far, a period equal to 6 *Manus* and 27 *Mahā-yugas* has elapsed from the commencement of the *Kalpa* up to the present i.e. the 28th *Mahāyuga*; and after passing through *Kṛta*, *Treta* and *Dvāpara* of the current *Mahāyuga*, we are now passing through the *Kaliyuga*.

71 *Mahayugas* make one *Manu* and a period equivalent to a *Kriyuga* known as 'Manu-sandhi' (i.e., the transition period between two *Manus*), is reckoned in the beginning of each *Manu* period. This means that a period equal to 4567 *Kaliyugas* have elapsed from the commencement of *Brahma's* day up to the present *Kaliyuga*. All *Siddhantas* with the exception of that of Aryabhata agree on these points, although they hold somewhat different views on other matters.

According to the modern *Surya-Siddhanta* and Aryabhata I, all the seven planets including the sun and the moon were together in the beginning of the present *Kaliyuga*. In other words, the mean longitude of each of these bodies was zero; but according to Brahmagupta and Aryabhata II, all the planets had such a general conjunction only at the commencement of the *Kalpa*, and not at that of the present *Kaliyuga* when they were situated within a range of 3 to 4 degrees from one another. There is yet another divergent view which will be explained later on.

This book relates the history of the study of the positions and motions of heavenly bodies and that of the development of the various aspects of astronomical knowledge in our country. The ancient name of our country is Bharata Varsha, Bharata Kshetra, or Bharata. Because this book contains the history of astronomical science in our country, it is titled "*Bharatiya Jyotisha Sashtra—(its) Ancient and Modern History*".

Samhita and *Jataka*, the two branches of astronomy, depend upon the motions of planets and stars. The chief aim of our astronomy is the prediction of actual planetary positions, that is foretelling what place in the sky a particular planet would be occupying at a particular time. Its complicatedness is inherent. An accurate knowledge of the mean motions and positions of planets emanates from an accurate knowledge of their true positions and motions. Even before they acquired the capacity to predict accurately their apparent positions, the ancients did possess a tolerably accurate knowledge of planets' mean motions and positions. This was the preliminary stage. The *Siddhantas* and other available astronomical works deal with the calculations of true positions and motions of planets. A considerable period of time must, however, have elapsed before man's knowledge of astronomy reached that stage.

The history of astronomy has, therefore, been divided into two major divisions, viz., (i) the *Siddhantic* period and (ii) the pre-*Siddhantic* period, and accordingly this book has been divided into two parts. 'Part One' gives the history of how the people in pre-*Siddhantic* age had taken increasing interest in astronomy, how the relevant knowledge had grown, and how it reached the stage of foretelling the true places of planets, this history being traced from the casual astronomical references found in the Vedas, *Vedāṅgas* *Smritis* and the *Mahabharata*, and the subsequent history up to the present time is given in 'Part Two'. The pre-*Siddhantic* period and consequently Part One, has again been sub-divided into two sections: (i) the *Vedic* period and (ii) the *Vedāṅga* period. The first section deals with the history of astronomy collected from references found in the *Vedic Samhitas*, *Brahmaic works* and some *Upanishads*. The second section deals with the history of astronomy gleaned from the *Vedāṅgas*, the *Smriti* works and the *Mahabharata*. The

Vedāṅgas contain two works whose whole subject matter is astronomy. These, however, deal with the mean motions and positions of planets and they are more ancient than the Siddhānta works, and that is why their study is given a place in Part One. A discussion of the limits of the periods to be assigned to the Vedic, the Vedāṅga and the Jyotiṣa-Siddhānta ages is given at the end of the part. 'Part Two' is devoted to the history of the three branches of astronomy.

The history of mathematical astronomy in this part has been presented in the order of *adhikāra* or chapters, as already mentioned, viz., the mean motions, true motions, etc. A description of the celestial sphere, the system of observation, the precession of solstices, etc., have been given in the same part. In the treatment of these subjects references to several works and authors are required to be quoted, and without their knowledge some difficulty is likely to be experienced in rightly appreciating the discussion. Hence a detailed history of astronomical works and their authors is given in the chapter on the mean motions of planets in the beginning of 'Part Two' and a discussion of the mean places and motions of planets will be found in the same chapter. The chapter on the 'true motions' is devoted to the study of true positions, motions of planets and a detailed description of the five parts of the *Pañcāṅga* (almanac) and that of different *Pančāṅgas* current in different provinces of our country.

An adequate idea regarding the subjects and the order in which they are dealt with in the two parts may be obtained from the table of contents.

(5) *Oh Dakṣa ! The praiseworthy and immortal gods were born after your daughter Aditi.* *Rk Samhita*, X, 72.

This means, in a general way, that some kind of Being or Existence arose first, then came into existence the directions and then the earth. The following lines from the *Rk Samhita* may be seen :—

॥ १ ॥ अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 ॥ २ ॥ अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 ॥ ३ ॥ अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥

“(1) Truth (of thought) and truthfulness (of speech) were born of arduous penance, thence was night generated, thence also the watery ocean.

(2) From the watery ocean was the year afterwards produced, ordaining nights and days, the ruler of every moment.

(3) Dhatri in the beginning created the sun and the moon, the heaven, the earth, the firmament and the happy (sky).’

These mantras occur in other Vedas also. The following description is given in a passage in *Taittiriya Brahmana* :—

अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥

The quotation describes that there was water in the beginning and that the earth was created thereafter. The *Taittiriya Samhita* also gives a similar account of the ‘creation’ in the following lines:—

अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥

According to this, water, air, and the earth, is the order of creation. The following passage from one of the Upanisads shows a more systematic treatment of the subject of creation.

अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥
 अथ तस्य विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥ तदा विश्वं प्रकृतं तदा ॥

“From this Soul (*Atman*), verily, space (*akāśa*) arose; from space, wind (*vāyu*); from wind, fire; from fire, water; from water, the earth; from the earth, herbs; from herbs, food; from food, semen; from semen, the person (*prāṇa*).”—*Taittiriya Upaniṣad*, 2.1 *Brahma Valli*.

are and) other Gods dwell there. If there be one who has known this, let him come here and relate it to us."

The object of the sage is to state that there can be no one who actually knows this.

Even then it seems that even in the Vedic age, people had a fair knowledge of the structure of the world and at least that of the configuration of the earth.

CONFIGURATION OF THE UNIVERSE

In many places, where a reference is to be made to the world, terms like *Rodasi*, *Dyāvapṛthivī* or their equivalents, denoting a combination of the heaven and the earth have been used, which in turn shows that the world was supposed to be divided into heaven and earth as its two parts. In some places the heavens are described as being three in number. Three heavens have been indicated at several places in the R̥gveda. In some places the heaven is described as the highest part of the sky or the surface of the sky. But in many other places the Universe is supposed to be divided into *Dya* (sky), *Anīarikga* (space) and *Pṛthivī* (earth) as the three parts; of these, the *anīarikga* lies in an intermediate position between the heaven and the earth and is the abode of the winds, clouds and lightning and the birds fly in it. These three parts are described in clear words in the following well-known lines of the *Purāṇa-Sūkta* :—

तस्य सप्तदशैव शिखरैः पृथुः पृथुः ॥ पृथुः पृथुः ॥

and corresponding to their high and low positions they are believed to have been created respectively from the head, the navel, and the feet of the Supreme Being.

The following verses may further be noted :—

यः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः ॥

यः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः ॥

॥. १. १. १. १. १. १. १. १. १. १.

"Oh people ! He is the same god Indra who kept the shaking earth in firm position.....who adjusted the expansive space and who supported the heaven."

तस्य सप्तदशैव शिखरैः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः ॥

॥. १. १. १. १. १. १. १. १. १. १.

"Oh Asvins ! May you give us heavenly medicines thrice from heavens, thrice from the earth and thrice from space."

The interpretation of the word *Abhyah* in the original text is "from the place where water-laden clouds dwell", meaning the sky (*anīarikga*) ; many proofs could be given in support of this interpretation and therefore it is clear that the word *anīarikga* stands for that space in which water-laden clouds move.

तस्य सप्तदशैव शिखरैः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः पृथुः ॥

॥. १. १. १. १. १. १. १. १. १. १.

"Oh Agni (fire), please come here along with all those *Maruts* (gods) who dwell in the expansive space".

These lines show that the space is the abode of 'Maruts' i.e. wind.

यस्य वा अन्तरिक्षं पश्यति ॥ अ. सं. १. २५. ७.

meaning "(Varuna) who knows the path of the birds flying through the space" shows that 'antariksha' is the space in which the birds fly.

It is clear from the following lines from *Altareya Brahmana* (11-6) that 'antariksha' is that space which lies between the heavens and the earth.

अन्तरिक्षं अन्तरिक्षं पश्यति ॥ अ. सं. १. १. ६.

That the sun is moving through the highest region of the heavens is described in many places. The following lines may be seen for this:—

उत्तमं तन्मयं अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.

"Oh Sun-god with agreeable lustre ! Cure the disease of my heart after ascending the highest point in the heavens."—*Rk Samhita*.

The idea that the sun shines at a very great distance from the earth can be seen from some of the following lines:—

यस्य पश्यति अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
यस्य पश्यति अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.

'Agni (fire) had to stand in a lower position before wind and space on account of the earth. The wind stooped low before the Sun and the sky on account of space. Similarly, the sun had to stand low in position on account of the moon and the stars ; and the moon had to 'bend low' before Varuna (god of rains) on account of stars"—*Taittiriya Samhita*.

The description appears to imply that the fire rests on earth, the wind takes shelter in space, the sun traverses the sky and the moon moves through the zodiac. It appears from this that the moon was supposed to occupy a higher position than that of the sun.

अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.
अन्तरिक्षं पश्यति ॥ अन्तरिक्षं पश्यति ॥ अ. सं. १. १. १.

* Six sentences following this, have been given with the necessary change in the gender and number of each of the words *Tefa* and *Samudra* (Sea) etc., in the original. They have not been repeated here.

THE MOON'S PLACE

Sāyaṇācārya, while commenting on the above verse, observes :
 "Yaska pakṣe tvāpa iti antarikṣaṇama, Yavahatrapo mahadantarikṣam
tarāṇām bṛikam candramasam."

This shows that according to Yaska and consequently according to Sāyaṇācārya also, the lines suggest that the moon is lower in position than the sun, because it moves in the space (sky). The moon is called a 'bird' that is one who traverses the space, in the first verse of this *Sūkta* and this lends an additional support to the view.

THE INFINITENESS OF THE UNIVERSE

The following lines express the idea that the earth as compared with the Universe is very small and the Universe is very expansive.

यथाविश्वं यथावन्तरिक्षं तथामहाभारतं ब्रह्मणः ॥
 अग्निं ते यवन्तं तस्यैवाग्निं तस्यैवाग्निं तस्यैवाग्निं ॥

ऋ. सं. १. ५३. ११.

"(Oh god Indra !) if the earth were to magnify itself to ten times its size (and if) men would live for eternity, then and then only the glory of your famous might and valour would be equalled by the heaven"—*Rk Sānhita*.

Here the term 'ten times' is only symbolic. It would be taken to mean many times. The object of the sage in giving this description in the verse is to suggest that the prowess of Indra is very great and it can equal the heaven in greatness. But the life of man who describes it is very short and the earth is also very small in size. If the earth were to grow to a bigger size and if men dwelling on it were to live to eternity, the prowess of Indra will be much extolled and will spread over the infinite universe. What we have to observe is that the idea that the universe is infinitely greater than the earth is clearly stated in this verse.

That the universe is infinite has been described in several places. The passage already quoted from *Taittiriya Sānhita* (3.11.1) may be seen as an example of this.

SUN, THE SOLE SUPPORT OF ALL WORLDS

The following lines may be seen as a proof that all worlds are supported by the sun.

यस्य धृतिं तृणवृक्षानि स्युः स्युः स्युः स्युः स्युः स्युः ॥
 तस्यैवाग्निं तस्यैवाग्निं तस्यैवाग्निं तस्यैवाग्निं तस्यैवाग्निं ॥

ऋ. सं. १. ११४. २.

"Seven horses are harnessed to that one-wheeled chariot ; but only one horse bearing 'sapta' (i.e. seven) names draws it. The wheel has three hubs or navels and it is eternal and unhindered, and all worlds stand supported by it (i.e. chariot)".—*Rk Sānhita*.
 Although the word 'sun' does not occur in the verse it undoubtedly relates to the sun.

SEVEN HORSES OF THE SUN

We, no doubt, come across a description of the sun's chariot as having seven* horses. However, statements are by no means wanting in Vedic literature which go to show that it is all metaphorical and that the sun has neither a chariot nor any horses.

अस्यो जतो अश्वीरुषो अश्वीरुषाश्चतस्रः ।

ऋ. सं. १. १५२. ५.

"The sun born without horses.....swiftly jumps high up in the sky :"
—*Rk Samhitā*.

ONLY ONE SUN AND ONE DAWN

The following verse from *Rk Samhitā* will show that there is only one sun and not two, twelve, or many in number.

एक एतान्वृषा एतद् एकः सूर्य

विष्वक् सूर्यः ॥ एकतो सूर्यो विभक्तिः.....॥

ऋ. सं. ८. ५८. २.

"(Only one sun is the lord of the universe, one dawn gives light to the universe".

It is worth noting that in the above lines, the dawn is said to be only one. The dawn is the twilight before sunrise. At many places in the Vedas, we come across the curious description of there being many dawns, because a dawn is observed every day before sunrise, but the fact was no doubt known that just as there is only one sun, so there is only one dawn permanently associated with him.

THE EARTH, ROUND AND SUPPORTLESS

DAY AND NIGHT

स वा एव स कालवर्तमानो नीलो स पालवर्तमानो स्यादेव एव
नक्षत्राणां स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात्
एवं स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात् स्यात्
स वा एव स कालवर्तमानो नीलो स पालवर्तमानो स्यादेव एव ।

ऋ. सं. १४. ६.

"He (i.e. the sun) neither sets nor rises. What is believed to be his set is makes night on this side and day on the other. Similarly, what is taken to be his rise in the morning is (as a matter of fact) his turning himself round at the

* Commenting on "Amiye Saptas mayah", Sri Shanker Pandurang Pandit, the editor of *Vedantia Yama*, writes (on page 683, Vol. II, of the issue for April 1878), "that the sun has seven rays is stated here in Rk 8-72-16 in clear words. From this it appears that the modern theory of the sun's rays consist of seven colours was not unknown to the Aryans in ancient times".

end of the night, when he makes this day on this side and the night on the other side. In fact he (the sun) never sets.*"—*Atiaveya Brāhmaṇa*.

The knowledge of the earth being round in shape and being suspended in space and separated from the sky, is clearly perceived through the above mentioned allusions from the *Brāhmaṇas*. Even in *Gopātha-Brāhmaṇa* (9-10) of the Atharva Veda, we come across lines almost similar in meaning.

It seems that it was known to the people even in the Rīgvedic age that the earth is round and stands supportless.

The following verse may be seen

अथर्ववेदः पृथिवीं पृथिवीं पृथिवीं पृथिवीं पृथिवीं ॥
न विद्यमानास्तिष्ठति पृथिवीं पृथिवीं पृथिवीं पृथिवीं पृथिवीं ॥

अ. सं. १. ३३. ८.

"The messengers (of periphery of the earth), who are shining with golden ornaments were unable to vanquish Indra, even when they were flying round the earth's periphery and running with great speed. He then covered** them with sun's light."—*Rk Samhitā*.

If the earth were flat, the sun's rays, immediately after sunrise, would have fallen at one and the same time on the whole earth, or at least on half of its surface; but references show that the rays instead of falling at once, do so one after the other. The following verse may be seen :—

अथर्ववेदः पृथिवीं पृथिवीं पृथिवीं पृथिवीं पृथिवीं ॥
न विद्यमानास्तिष्ठति पृथिवीं पृथिवीं पृथिवीं पृथिवीं पृथिवीं ॥

अ. सं. १. ३३. ८.

"The brilliant sun filled with light the regions of the heaven, the space and the earth."—*Rk Samhitā*.

The sun is rising and stretching out its arms, putting the world to sleep by turns and awakening it by turns by means of its lustre.

The mantra "the sun rises causing a gradual sleep and a gradual awakening" may be taken to mean that as the sun traverses the sky, there is night fall in some parts of the world which are thus enveloped in darkness; and because it gradually throws light on some other parts, there is day time there. This betokens a knowledge of the roundness of the earth.†

Any such references in the Vedas as to show the earth as having been divided into *Meru-mountain*, *Jambudvīpa* and other seven islands can not perhaps be found.

* The speaker is observing this with respect to his own place. The words "this side" refer to the side on which he stands with respect to the sun. By the words "turns himself round" he means to say that the sun, after moving in one direction till evening, changes his direction after dawn after sunset.

† Commenting on this verse, Shri Shanker Pandurang Pandit the editor of *Vedarth-Yatna*, observes (*Vedarth Yatna*, Page 380, Vol. I), that "The words 'Parināham chakra-nātha' clearly show that our Aryan ancestors, at the time of composing these verses doubtless knew that the earth is not flat but round spherical in shape".

† It is clear that the Samhitās of all the Vedas, the Brāhmaṇa works and the Upaniśads were not compiled in the same age. It is very difficult to assign limits to their times (contd. to next page)

"Dirghatama, the son of *Manata*, having grown old in the 10th yuga, became the charioteer (in the form of *Ritwik*) of the *Karma* (action) which leads to some (divine) result".—*Rk Samhitā*.

Sāyana, in his commentary on the above verse, says that Dirghatama after happily passing his life for 10 yugas through the grace of Ashwecs, finally attained old age. He does not state in clear words what a 'yuga' should be taken to mean, still the context of his writing suggests that it should be interpreted as ten *kr̥tādī* yugas.

युगं युगं त्वत्तु यत्तु यत्तु यत्तु यत्तु यत्तु ॥

ऋ. सं. १. ५.

"Oh God of fire (agni) ! Give riches and success to us who offer new words of praise to thee for the sake of sacrifices in each yuga".—*Rk Samhitā*.

यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु ॥

ऋ. सं. १०. ६७. १.

"The herbs which created by Gods in three yugas before"—*Rk Samhitā*.

In his commentary on the above line Sāyanācārya interpreted the word *Trīyuga* as either the three yugas *Kṛtā*, *Tretā* and *Dvāpara* or the three seasons *Vasanta* (Spring), *Varṣā* (Rains) and *Sarad* (Autumn).

The same mantra occurs even in Taittiriya Samhitā in the form—

यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु ॥

Even in Vajasaneyi Samhitā the same *mantra* is found in the following form, and Mahidhar, the commentator has interpreted the word 'Yuga' as the three seasons—spring, rains and autumn :—

यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु ॥

A reference to the word 'Yuga' is made in Vajasaneyi Samhitā in the following line :—

यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु यत्तु ॥

ऋ. सं. १२. १११.

In all these references the word *yuga* has undoubtedly been used to denote some unit of time, but none of them clearly indicates the number of years which the word is supposed to denote. In the Vedāṅga Jyotiṣa, a *yuga* is supposed to be a unit of 5 years. It cannot, however, be said for certain that the word is definitely used in the same sense as in the above lines, nor can it be said for certain that it is not so used; for it will be seen later on that the names *Samvatsara*, *Parivatsara*, etc., which form parts of the five-yearly *yuga* of the Vedāṅga Jyotiṣa do occur in the Vedas.

In the quotation "Dirghatama became old in the tenth *yuga*" it is not the object of the writer to point out some infirmity of Dirghatama. It is clear that he intends to express some speciality about him; and if it be taken to mean units of 5 years it would on the other hand show his infirmity, as he would be regarded to have attained old age at fifty. Therefore, instead of assuming that the span of life was a thousand years, if it be assumed as of some limited number of years, say a hundred years, the term *yuga* has to be taken to mean at least a period of ten years. From this and from the R̥gveda quotation "We praise you in new terms in every *yuga*", it appears that the *yuga* must have been a unit of time smaller than the span of human life, that is smaller than 100

It must be said that the world yuga had no standard meaning and conse-

॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥

"The yuga (cycle) of the node of Mercury consists of 35,750,224,800 years and that of the node of Venus of 119,167,016,000 years." The number of years

KRĪTA AND OTHER WORDS OCCURRING IN THE VEDAS

[illegible][illegible][illegible]

11. ~~102512~~

It will be seen that just as a prayer, 'May the manes, etc., protect us' occurs at the end of the stanza, the prayer, 'May *Kṛta* and *Dvāpara* protect us' also does appear there.

ॐ नमो भगवते वासुदेवाय ।

श्रु. श्रु. ३०. १८.

"*Ādinavadarśa* is to be offered to *Kṛta*, *Kalpī* to *Tretā*, *Adhikālpī* to *Dvāpara* and *Sabhaśasthānu* to *Āskanda*"—*Vājasaneyya Saṁhitā*.

The commentator *Mahidhara* renders '*Ādinavadarśa*' as one who can see fault known as *Ādina*, and '*Kalpī*' as one who imagines. The *Taittirīya* *Brahmaṇḍa* gives a similar but slightly different line under '*Puruṣamedha*', which runs thus :—

ॐ नमो भगवते वासुदेवाय ।

श्रु. श्रु. ३. ४. १.

"A *Sabhavi* should be procured for *Kṛta*, an *ādinavadarśa* should be offered to *Tretā*, *bahīśada* to *Dvāpara* and a *sabhaśasthānu* to *Kālī*"—*Taittirīya Brahmanā*. This stanza names the 'sacrificial persons' which should be offered to different deities. The commentary by *Mādhava* gives the meanings of these terms as follows :—

'*Sabhavi*' is one who sits in the gambling hall; an '*ādinavadarśa*' is the observer examiner of the game (of gambling) ; a '*bahīśada*' is the one who witnesses the game without taking part in it, and a '*sabhaśasthānu*' is the one who does not leave the hall even when no game is being played. The story of *Harīścandra* occurs in the *Āitareya Brāhmaṇa*. *Harīścandra* had no son. He invoked god *Varuṇa* to grant him a son, promising that the son would be offered to him in sacrifice. He then got a son who was named *Rohita*. After some years when the son was being sacrificed, he ran away into a forest. After wandering in the forest for a year he returned to his village. At that time, *Indra*, taking a human form, met him and advised him to return to the forest. This happened repeatedly for four years. When *Rohita* returned again, *Indra* said to him,

ॐ नमो भगवते वासुदेवाय ।

श्रु. श्रु. ३३. १५.

"One who sleeps becomes *Kālī*, one who sits becomes *Dvāpara*, one who gets up becomes *Tretā*, and one who becomes a wanderer attains *Kṛta*. Therefore keep on roving, keep on roving."—*Āitareya Brāhmaṇa*.

ॐ नमो भगवते वासुदेवाय ।

श्रु. श्रु. ४. ११.

"The four *stomas* are *Kṛta* and five are *Kālī* and hence the *Jyotiṣoma* sacrifice should be *Catusṣoma*"—*Taittirīya Brāhmaṇa*.

This gives a limit to the number of '*stomas*' i.e. (oblations). Some say five and some only four. Offering five would be *Kālī* which is bad and offering four would be *Kṛta* which is good, and that is why the rule of offering four has been stipulated.

It can not be proved that the words *Kṛta*, etc. have been used in the definite of time; still the idea that they represent four deities is quite

clear from the above sentences. Similarly, the belief that Kṛta indicated something good, and others were increasingly inferior, Kālī being the worst, is also indicated in these sentences. As it is evident from several lines in the Vedas that yugas were regarded as units of time and they were believed to be four in number, there is no doubt that the origin of the deeply rooted views about the yugas in the post-Vedic age lies in these very lines from the Vedas in which the terms Kṛta and others occur. The word Dvāpara occurs in *Gopātha Brāhmaṇa* (1.28) in the sense of a unit of time.

THE FIVE-YEAR CYCLE

In the Vedāṅga Jyotiṣa the yuga is taken to be a cycle of five years. The names of these years are *Samvatsara*, *Parivatsara*, *Idāvatsara*, *Anuvatsara* and *Iadvatsara*. Although these names do not occur in the Vedāṅga Jyotiṣa itself, there is no doubt that these were the names of the years, in as much as they occur in the Vedas, and writers like Garga and others have given these very names. Let us see what the Vedas state about this:—

संवत्सरं पञ्चः परिवत्सरः द्विवत्सरः ॥

अनुवत्सरः त्रीणि वाचस्पतिः परिवत्सरः ॥

श्रु. सं. ७. १०३. ७, ८.

It can not be definitely said that the words *Samvatsara* and *Parivatsara* have been given in this verse to show that this is the correct order of the names, still it is certain that the names did occur in this very order. And looking into the fact that when any thing is to be said about the year in a general sense, the word year is generally rendered in the Rīgveda by some such words as *Sarad*, *Hemanta*, etc. which denote a season, it is thought that the above words must be the names of two of the years comprising the five-year cycle. The word *Parivatsara*, however, occurs in the Rīgveda at one more place (10-62-2); the names of the other three years are nowhere to be found.

संवत्सरं पञ्चः परिवत्सरः द्विवत्सरः ॥

श्रु. सं. २६. ४५.

अनुवत्सरं त्रीणि वाचस्पतिः परिवत्सरः ॥

संवत्सरं पञ्चः परिवत्सरः द्विवत्सरः ॥

श्रु. सं. ३०. १६.

This *mantra* occurs in *Puruṣamedha* and states what particular kinds of women are to be offered to *Samvatsara*, *Parivatsara*, *Idāvatsara*, *Iadvatsara* and *Vatsara*. In both the *mantras* from *Vājasaneyi Sāhita*, the order of the names of five years is the same. The second *mantra* mentions the name *Samvatsara* again after giving the five names beginning with *Samvatsara*.

The *Taittirīya Brāhmaṇa* gives the following lines:—

संवत्सरं पञ्चः परिवत्सरः द्विवत्सरः ॥

श्रु. सं. १. १०.

These lines mention only four names. Of these, the first three are given in the same order as in the Vajasaneyi Samhita and the fourth is Anuvatsara which is different therefrom.

॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥
॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥

An almost equivalent quotation from the *Vajasaneeyi Samhitā* has already been given above. Both of them give the same order of year-names; there is, however, some difference in respect of the animals to be offered in the sacrifice. Even in these lines there is the repetition of the name *Samvatsara* at the end after the mention of the usual five names.

पु. प्र. ३. ४०. ४.

Mādhavācārya, however, interpretes Iduvasisara as a synonym for Anu-
vatsara.

These passages mention a varying number of years, some of them mention five, others six, while some others only four and these too have been given in a different order every time. It cannot be definitely said whether these represent the five yearly cycle which was current in the Vedāṅga Jyotiṣa agc. However, the reference to the 5-year cycle and the names of years comprising it in the post-Vedic works which occurs at several places must have had some support of tradition.

THE YEAR

Let us now consider the connotation of the two terms, the year and the month. The word *Vars*, which at present denotes a unit of 364 or 365 days or some such interval, is not found in the same sense in the R̥k-Yaju-Sam-*hitas* or the *Aitareya*, the *Taittiriya*, the *Tanp̥ya* or the *Gopatha Brahmanas*, but it does occur in the *Satapatha Brahmana* (2-2-3). In *Rigveda*, the names of seasons like *Sarad* have been for use denoting a year. Similarly, the words *Samvatsara* and *Parivatsara* are found so used in some places. In both the versions of the *Yajurveda* words like *Sarad* and *Hemanta* have not only been used several times in the sense of a year, but the word *Samvatsara* appears to have been used much more frequently. The word '*havana*' has been used in

the sense of a year in the Gopātha Brāhmaṇa (6-17). The word 'sana' has also been used in the sense of a year in the Vājasaneyi and Rk Samhitās. The following *mantras* may be cited in this respect:—

सन् अस्मिन् वर्षे सन्तु मृत्युर्वासाः ॥ अ. सं. १६. ४६.

सुवर्णवर्षात्तु सन्तु मृत्युर्वासाः ॥ अ. सं. ०. ४०. २.

सन्तु मृत्युर्वासाः ॥ अ. सं. १०. ८५. ५.

Months were Lunar

It was but natural that in the Vedic age the months were lunar, and it is needless to give here any quotations in support of this. Some of them will be given when the study of the 'month' would be exclusively taken up. The term '*Purnamās*' which is applied to full moon days and which literally means 'the *tithi* on which the month ends' is well known. It has already been pointed out that the term '*māsa*' which was originally a synonym for the moon was later applied to the time-unit of a month. No convenient means is available for measuring a solar month like the lunar one, which is naturally measured by the moon. The measure of a solar month can generally be known only by calculations. Therefore, it is clear that at the beginning man must have adopted the lunar month for their use and that the solar month came into being afterwards.

The Year was Solar

The first impression would be that because the months* were lunar, the year also must have been lunar. It is, therefore, to be considered whether the year was a lunar or a solar one; and if solar, whether it was sideral or tropical. The following quotations clearly mention the measure of a year in terms of days or months.

वसन्ति यवन्ति द्वाविंशतः ॥ अथ न अश्विनः.

अ. सं. १. २५. ८.

"Dhātavrata (Varuṇa) knows the twelve months; (and) the animals created during that period; (and) he knows (the intercalary month) which is created (near the twelve months)"—*Rk Samhitā*.

Although the word 'intercalary' has not been explicitly stated here, it is clear from the context that the intercalary month is intended and this 'Rc' is rendered in this very sense traditionally. The western scholars also accept this sense. That the year commonly consists of twelve months has been clearly stated in this Rc.

द्विंशत् तिन्त्रिंशत् चत्विंशत् पञ्च पञ्चाशत् ॥

अथ गुणं अथ तिथ्यात् अथ सप्त शतं तिथिर्वासाः ॥

अ. सं. १. १६४. २२.

*This statement may appear vague, because only the term 'year' is under consideration here. A study of the civil, lunar and solar months will be taken up later.

"The wheel (of time) having twelve spokes revolve round the heavens, but it does not wear out. Oh Agni ! 720 pairs of sons ride this wheel" — *Rk. Samhita.*

इति त्रैलोक्यं श्रीमन्महादेव उवाच ॥
 त्रैलोक्यं त्रैलोक्यं त्रैलोक्यं त्रैलोक्यं त्रैलोक्यं ॥

म. म. १. १३४. ४८.

"Twelve spoke-boards, one wheel, three navels. Who-understands these ? In these there are 360 Sankus (rods) put in like pegs which do not get loosened" — *Rk. Samhita.*

It is clear that this curious description refers to the year, the 12 months are the twelve spokes of the wheel and the 360 days are the 360 nails. 'The day and night' is a couple and 360 such couples give the number 720.

महानमो महानमो महानमो महानमो महानमो ॥

महानमो महानमो महानमो महानमो महानमो ॥

म. म. १. १. १४.

"Oh Soma (Juice) ! You are taken in by the 'upayāma' (i.e. a dish, a pan). You are Madhu, you are Mādhava, you are Sukra, etc." — *Taittiriya Samhita.*

This gives the following names of the twelve months ; Madhu, Mādhava, Sukra, Suci, Nabhas, Nabhasya, Isa, Uja, Sahas, Sahasya, Tapas and Tapasya. It also gives *Samśarpa* as the name of the intercalary month. Mādhavācārya, while commenting on the above lines, observes that the word *Amhaspati* means the suppressed or decayed month.

महानमो महानमो महानमो महानमो महानमो ॥

महानमो महानमो महानमो महानमो महानमो ॥

म. म. १. १. ११.

"Madhu and Mādhava are the (two) months* of spring ; Sukra and Suci of summer ; Nabhas and Nabhasya of the rainy season ; Isa and Uja of autumn ; Sahas and Sahasya of late autumn ; and Tapas and Tapasya of winter (winter) — *Taittiriya Samhita.*"

महानमो महानमो महानमो महानमो महानमो ॥

महानमो महानमो महानमो महानमो महानमो ॥

महानमो महानमो महानमो महानमो महानमो ॥

महानमो महानमो महानमो महानमो महानमो ॥

*The word 'Ritu' appears to have been used in sense of a 'month' in the original.

The above lines first give the terms *Samsarpa*, *Malimlucā* (now usually given as a synonym for the intercalary month) followed by Madhu and other names of 12 months, and then comes the thirteenth name '*Amhaspati*'. This shows that *Samsarpa*, *Malimlucā* and *Amhaspati* must have some differences in their meanings.

न अश्विनमासादश्विनमासं अश्विनी मासो नक्षत्रवत्

पृ. श्रु. ३. १.

"They purchased 'Soma' juice from the thirteenth month, and hence the thirteenth month is censurable".—*Atiareya Brahmana*.

शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं

शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं शशिनं

पृ. श्रु. ७. १७.

"A year has 360 days, a year has 720 days and nights together".

अश्विनमासादश्विनमासं अश्विनी मासो नक्षत्रवत्

अश्विनमासादश्विनमासं अश्विनी मासो नक्षत्रवत्

अश्विनमासादश्विनमासं अश्विनी मासो नक्षत्रवत्

"Should the reins in a horse-sacrifice be twelve cubits in length or thirteen? The year consisting of (six) seasons is a kind of bullock whose hunch is the thirteenth month. The horse-sacrifice is the best of all sacrifices. The year in the form of a bullock has got a hunch (in the form of the 13th month)".—*Atiareya Brahmana*.

It is clear from the above quotations that the year was solar in the Vedic age. The natural means of measuring a year used to be one complete cycle of seasons, just as the natural means of measuring a day was the period between two consecutive sunrises or that for measuring a month used to be the period between two full moons. The year as a unit of time could not have come into existence if seasons were not to exist. It is, therefore, obvious that the year must have been solar. During the earliest stages of observation, the seasons were naturally supposed to recur after 12 lunar months. Although, one complete cycle of seasons required 11 days more than 12 lunar months, it must have been difficult to guess this correct measure in the beginning and one year must have been supposed to consist of 12 lunar months for a considerable period of time. As a result of this supposition, however, the month which used to fall in summer must have shifted to occur in winter and later on in the rainy season and thus have gradually receded through all the seasons. Every month of that calendar, like the Muharram of the Muslims, was bound to pass through all the seasons, thus completing a revolution in 33 years. After the passage of several such cycles of 33 years, it must possibly have occurred to people to insert an intercalary month, and the fact that such an intercalary month used to be reckoned in the Vedic times goes to prove that the year was solar in those days. This may appear very trivial today, but it certainly was no ordinary matter that our people conceived the idea of inserting an intercalary month in those days of hoary antiquity. As a matter of fact it is extremely significant.

The ancient Romans who at one time were a very powerful nation used to regard a year as consisting of 10 months for quite a long time. Some of those parts of the Vedas which contain references to intercalary months were compiled before 1500 B. C. Even European scholars accept this view. The reference to intercalary months has not been made in such passages as a matter of special or unusual interest. It, therefore, appears that the idea had become a matter of common experience long before that time.

Now there is no clue to find out the number of months that used to lapse before the intercalary month was inserted. According to the current practice an intercalary month is inserted after about 32 or 33 months by mean reckoning. The figure would vary by a month or two if true motions are taken. Even then it occurs after 32 or 33 months on an average. It used to occur after 30 months according to the Vedāṅga Jyotiṣa. It is not known after how many months an intercalary month used to occur in the Vedic age. However, there must have been some rule for this.

The terms 'Malimlūca', 'Satisarpa' and 'Ainhaspati' occur in the lines quoted above. The following lines show that the intercalary month is known as 'Malimlūca'.

रविमं विप्रमं मल्लमल्लमः सति सति सति

—सतिः

"The lunar month which is skipped over by the sun is known as *Malimlūca*" —*Vyāsa*.

मल्लमल्लमं मल्लमल्लमं मल्लमल्लमं मल्लमल्लमं

—मल्लमल्लमं

"When the sun is found to cross only one *Rāśi* in two months the former is called the *Malimlūca* and the latter the *Suddha* or proper"—*Maitreya Sūtra*.

The terms *Satisarpa* and *Ainhaspati* are defined as :

सति सति सति सति सति सति

—सति सति सति

This shows that the *Asamkṛānti* or intercalary month was called 'Satisarpa' and the *Dvisamkṛānti* or missing month as 'Ainhaspati'. The author of *Muhurta Cināmaṇi* has, in Chapter I, verse 47, described the characteristics of the above two months as follows :—

"When missing month occurs, two intercalary months also occur in that year. The one preceding it is to be known as *Satisarpa* and the one following it as *Ainhaspati*. It is not known if the terms carried some such meaning in the Vedic age.

It has been shown that the year was solar. Whether it was tropical solar or sidereal solar will be considered later on.

THE MEASURES OF SĀVANA LUNAR AND SOLAR YEARS

Let us see whether any kind of year other than the solar was in use. Out of the five astronomical measures of time viz. *Sāvana* (sacrificial), lunar, solar, sidereal and Jovian, no description of either the sidereal or the Jovian year is found in clear or even in implicit terms in the Vedic literature. The remaining three terms will now be considered.

—: sMOIIOJ as „Kala Maddava“ as follows:—

सामान्यतः संप्रदायः संप्रदायः संप्रदायः ।

अष्टोत्तशायः एकः सीमदत्तां वदन्त्यै शब्देनाभिधीयते नाद्वैतानामभेदाभावात् । तेषां पदार्थैः...
पदार्थैश्च पञ्चकन एका भावः संपद्यते नाद्वैतादजाभिधासिः साध्य संभवत्यस्य ॥

It seems to have come to notice that the lunar year did not consist of 360 days but was somewhat shorter.

॥३॥

meaning "a day is omitted after some *sadāhas* and *māsas* are observed". It indicates the circumstances under which a day is to be omitted during the period when a sacrifice continues. Because a lunar month is equivalent to 29 $\frac{1}{2}$ days, two such months would be equivalent to 59 days. Therefore, if a '*sadāha*' sacrifice is commenced on the first day of a lunar month, the second lunar month would end one day earlier than the completion of two sacrificial months (i.e. 60 days). The sacrificial priests, after actually noticing this discrepancy, must have felt the need for omitting* one day from one

[illegible]

of the *sadahas* and this must have resulted in the introduction of the '*usarginamayama*' sacrifice.

The reason for omitting a day has been given in the *Tandya Brahmana* as follows:—

यत्तु न एतन्मयमवशिष्टं ॥

त. ब्र. ५. १०. ३.

"If a day is not omitted the year will swell like the bellows made of leather".

The line '*utsrīyam notsrīya*' given in the stanza following the one in which the lines quoted above occur shows that the Brahmanavādins held deliberations for several days on the question as to whether to omit a day or not, and it was but natural that it so happened. It can not, however, be clearly understood as to how many days used to be left out during a year; still the idea that a lunar year consisting of 12 lunar months was shorter than 360 days was no doubt prominent in it. In short it may be stated that the civil, the lunar and the solar years were in vogue in the Vedic age.

THE AYANAS

Let us now consider the *ayanas*. *Ayanas* are two—the *Uttarayana* and the *Dakṣiṇāyana*. There appear to be two views regarding the period of time to be indicated by them and the sun's position at those times. The authors of Siddhantic Astronomy are, however, unequivocal on this point. The two terms have clearly been defined by them, viz., the period of the sun's movement from the beginning of Capricornus to that of Cancer is known as *Udagāyana* and that from Cancer to Capricornus as the *Dakṣiṇāyana*. If the sun be observed on any consecutive four or five days during *Udagāyana* at the time of rising or at any other fixed time, it would every day be found at a point shifted to the north as compared with its position on the preceding day, irrespective of whether the sun is at the north or south of the celestial equator. During *Dakṣiṇāyana* the sun is found to be moving from north to south. According to some writers *Udagāyana* in the northern hemisphere is the period from the beginning of *Śiśira* to the end of *Grīṣma*, and according to some others it is from the middle of *Hemanta* to the middle of *Grīṣma*. The above astronomical meaning of *Udagāyana* has generally been accepted in all modern works, but the word '*ayana*' appears to have been carrying a different sense in early days. *Saṃpātha Brahmana* contains the following:—

यन्ति येनैतं यत्तुः । नैतं यत्तुः सत्त्वितः सत्त्वितं सत्त्वितं (यत्तुः) सत्त्वितं ।
यत्तु नैतं यत्तुः.....यत्तु सत्त्वितं सत्त्वितं सत्त्वितं ।

त. ब्र. ५. १. ३.

The words *Udagāyana* and *Dakṣiṇāyana* have not been explicitly used here, but it is simply stated that the sun is said to be entering the region of gods when it turns north and the spring, summer and the rainy seasons

Some astronomical Samhitā works appear to use the term 'ayanās' in this very sense, for they speak of the Udagāyana as the day of the gods; and to the gods residing on the *Mount Meru*, the sun in its northward course is continuously visible for six months, which shows that the term Udagāyana is to be applied to the continuous position of the sun to the north of the equator. The *Bhāgavata* also gives the same meaning.

नै.सं.६.५.३.

५.....उत्तरार्धे प्रथिते वैशाखशुद्ध अश्विमास अष्टमि तारिखस्य सायं ४ वाजे अत्र प्रथिते
विशालीय अश्विमास अष्टमि तारिखस्य सायं ४ वाजे अत्र प्रथिते.

SEASONS

The names of seasons like *Sarad* and *Hemanta* occur at many places in Rk Samhitā. The word 'Ritu', however, does not occur by itself as frequently in the Rk Samhitā, as it does in both the schools of Yajurveda and Bṛhadya Brāhmaṇa. The Rīgveda Samhitā does not on the whole appear to attach much importance to the seasons. The 28th and 29th sections of the 3rd chapter of the 5th aṣṭaka of Rk-Samhitā give about 50 to 60 sentences

in which prayers to gods like 'Sam na Indragñi bhavādm' meaning 'may gods Indra and Agni bless us' are found but nowhere is found a single sentence to the effect that the year, seasons, months and nakṣatras may bless one. One would expect to find in an equal number of stanzas in the *Yajurveda* at least some stanzas devoted to prayers to seasons.

Number of Seasons

Excepting the Rk Samhitā all other Vedic works mention six as the number of seasons at various places, and at many of these places the names of all the seasons have been mentioned collectively (see *Tal. Sam.* 4. 3. 2; 5. 6. 23; 7. 5. 14; etc. Some of the places have already been pointed out above).

At several places however it is stated that the seasons are five in number : for instance,

पञ्चसर्गोऽयं पञ्च ऋतवः संवत्सरः ॥.....पञ्च वा ऋतवः संवत्सरः

त. श्र. १. ७. १०.

'Sacrifice should be performed in five Saradīyas (i.e. seasons)..... because a year has 5 seasons'. Since the year was supposed to have five seasons, it seems that Hemanta and Śisira formed one season. The following line may be seen for this purpose.

पञ्चसर्गोऽयं पञ्च ऋतवः संवत्सरः

प. श्र. १. १.

'Twelve months comprise five seasons of which Hemanta and Śisira together form one'.

Even from the Taittirīya Samhitā, Taittirīya Brāhmaṇa and Satapatha Brāhmaṇa it is seen that when the year was supposed to have five seasons, Hemanta and Śisira were taken together to form one. Even Mādhabaśārya observes (under 'determination of seasons' in Kāla Mādhaba) that in such cases the season of Śisira should be included in Hemanta and cites authorities in support of his argument. In some rare places (see Satapatha Brāhmaṇa 3. 4. 4. 17.) the seasons are said to be three in number.

The First Season

In the Vedas, wherever all the six seasons are mentioned collectively, they are found to begin with Spring. In addition there are explicit statements that Spring is the chief season, e.g.

पञ्च वा ऋतवः पञ्चसर्गः ॥

त. श्र. १. १. १. १. १. १.

"Spring is the mouth of the seasons."

पञ्च ते (संवत्सरः) ऋतवः ऋतः ॥ ऋतवो ऋतवः ऋतः ॥ ऋतः

पञ्च ॥ ऋतवः ऋतः ॥ ऋतवो ऋतः ॥

त. श्र. १. १. १. १. १.

"The spring is the head (of the year) ; the summer is the right wing ; the monsoon forms the tail ; autumn the left wing, and winter the central part."

Similar statements are found at two more places. Here Hemanta is stated to be the middle of the year, and the rainy season its tail.

If the year be compared to a bird, the following chart would correctly represent the position stated above :

(Left wing)	Autumn	(Belly)	Winter	(Right wing)	Summer
(Mouth)	Spring				
		(Tail)	Monsoon		

Commencement of Seasons

अथानिर्गम्यतां यत्नं कीदृशं नक्षत्रं पश्यतां मयः

श. स. ३. ५. ३.

"Two faced is the vessel of seasons ; who knows which one is the mouth of the seasons ?"

This remark seems to suggest that none can know when a particular season commences. And that is correct. The seasons depend upon the sun's position. If in a certain year a solar month begins, say, simultaneously with a lunar month, it would in the following year commence from the 12th day of the light half and in the subsequent year from the 8th day of the dark half. Therefore, the commencement of a season with respect to the tithi is irregular. Not only this, but it is somewhat irregular with respect to the sidereal solar month also. At present rains start within 4 or 5 days of either ahead or after the beginning of the nirayana Mrga nakshatra. The commencing day of a season varies from place to place also ; it is, of course, obvious that the variation would be about five to ten days ; still it was but natural for the ancients to express their thoughts as in the above quotation.

It would be very difficult to obtain an accurate knowledge of the transition moments of two half-months or those of the seasons in the absence of an accurate knowledge of the motions of the luminaries and of the means of measuring time. The following myth will show how difficult it was for the primitive man to note the ending moments of the full moon and the new moon as also the ending of one season and the beginning of the next.

मार्गः ३ यतः सूर्याय पश्चिम दिशः स ३ सूर्याय एव प्राचीनदिशति

पश्चिमदिशति : सति पश्चिमदिशति प्राचीनदिशति ॥ ३५ ॥ स दिशतः पश्चिमः ॥

३ सूर्याय पश्चिमदिशति प्राचीनदिशति : सति प्राचीनदिशति पश्चिमदिशति ॥

श. स. ३. ५. ३.

"After mankind was created by Prajāpati, his *parvas* (knuckles) became loose. The *samvatsara* (year) itself represented the Prajāpati. The two 'points' of day and night i.e. twilight, the full moon and the new moon, and the commencement of seasons—these are his *parvas*. The gods diagonalised the disorder. They cured the 'joints' of day and night and set them in their correct places by maintenance of *agnihotra* (sacred fires). The full and the new moons were correctly adjusted by the *Paurṇamāseṣi* and *Darśeṣi* and the 'joints' of the seasons were set right by means of the '*Caturmāsya* *yajñā*' (i.e. four monthly sacrifices)".

This story points to some kind of the association of the knowledge of time with the sacrificial system.

THE MONTHS

Let us now consider the question of the month. It has already been dealt with at some length in the course of the discussion under the heading 'The Year'. Madhu and other names of months have already appeared in the foregoing discussion. In addition to this, some more names are found in *Taittirīya Brāhmaṇa* and they are now being given in the following quotations which include some different names of seasons and half-months also :—

अथ षष्ठे ॥ पवित्रं पवित्रयज्ञसंस्मृत्यैवमवधीश्वरान् इति ॥ एष एव नमः ॥
एष एव तैत्तिरीयः ॥ एष मासः ॥ अथ षष्ठे ॥ अतिपुष्टेय उपवीर्यश्रेष्ठः प्रजापतिः
संवत्सर इति ॥ एष एव नमः ॥ एष ऋतवः ॥ एष संवत्सरः ॥

तै. श्र. ३. १०. ६.

The half-months referred to above are given in the following list. These are the names of the 24 half-months occurring in one year :—

पवित्रं पवित्रयज्ञं पूजते सधुः ॥ यतो यवत्पानात्पूरयतः ॥
यतो योनिव्यवृत्तवर्गः सधुः ॥ सधुत्वात् सधुः पानात्पूरयतः सधुत्वात् ॥
यवत्पवित्रयज्ञसंस्मृत्यैवमवधीश्वरान् इति यजोः ॥
अर्धपवित्रं इति यजोः यवत् ॥

तै. श्र. ३. १०. १.

These are the names of 24 half-months occurring in a year. Following is the list of names of months.

अवधीश्वरान् पूजते योनिव्यवृत्तवर्गः ॥
अर्धः पवित्रयज्ञसंस्मृत्यैवमवधीश्वरान् ॥
यवत्पवित्रयज्ञसंस्मृत्यैवमवधीश्वरान् ॥

तै. श्र. ३. १०. १.

It contains 13 names, apparently including that of the intercalary month.

अतिपुष्टेयः पूजते यवत्पवित्रयज्ञसंस्मृत्यैवमवधीश्वरान् ॥

तै. श्र. ३. १०. १.

At the end, the 'samvatsara' (year) is declared to be representing the Prajāpati in the following:—

पृ. ३०४.

(Madhvādi and Caitrādi systems)

(i) That the full moon day on which the moon becomes full near the star Citra (Spica) is to be termed Caiti-Purnima, and

To come to know that the moon always becomes full near particular nakṣatras is the first stage; that introduction of names like Citṛi, Vaiśākhi, etc. for these full-moon nights after a lapse of time is the second stage and the third stage is the establishment of a complete nomenclature to start with, as being governed by the rule "*Sāsmiṇ Paurṇamāsī*" (Pāṇini 4-2-21) meaning, "it is so called, because the full moon night of that name falls in that month". The names of nakṣatras are found in all the above mentioned Vedas at many places; but it is only at two places that the moon has been explicitly mentioned as becoming full near a star. The passages are quoted below.

संश्लेषात् दीर्घस्योपात्तौ एकादश्यां दीर्घत्वोपात्तौ संश्लेषस्य पक्षी यदेकादशकतत्त्वात्
 ना एव एतादृशं यस्मिन् साक्षादेव संश्लेषस्य दीर्घत्व आनं वा एते संश्लेषस्याभिधीयते
 य एकादश्यां दीर्घत्वोपात्तौ अथवा वा एते संश्लेषस्याभिधीयते य एकादश्यां
 दीर्घत्वोपात्तौ अथवाः फलान्तीर्णत्वमस्य दीर्घत्वस्यैव वा एतत् ॥ १. ॥ संश्लेषस्य
 यदन्तर्नीर्णत्वमस्य यस्मान् एव संश्लेषस्य दीर्घत्वोपात्तौ तस्यैव फलं यस्मिन् यदस्यैव फलं यदस्यैव
 फलं यदस्यैव दीर्घत्वोपात्तौ वा एतत्संश्लेषस्य यदस्यैव फलं यदस्यैव दीर्घत्वोपात्तौ वा एतत्संश्लेषस्य
 दीर्घत्वोपात्तौ अथवा फलं यदस्यैव फलं यदस्यैव दीर्घत्वोपात्तौ अथवा फलं यदस्यैव फलं यदस्यैव

५१७५

secreted in the very beginning of the year.

Those who become consecrated on the Ekashtaka day get

seasons. Those who consecrate themselves on the Ekastakā day become

consecrated against the 'confusions' of the year. The year becomes dis-

should get consecrated on the full moon day of the Phalguna, because

Phalguna full moon is the 'mouth' of the year. Hence, (such people) are taken as connected from the very beginning of the year. But such people

have to accept one 'nitya' (draw back) viz. that the 'Viśvān' (equinox)

occurs in the cloudy season (sammēdya). Hence, one should consecrate in the Citra-ful moon day. The Citra-ful moon day is the 'mouth'

of the year. Hence, those (who commence their sacrifice on this day) are

back. One should pass through consecration on the 4th day before the full moon. It is said to be consecrated from the month of the year. This involves no law-

moon day, thereby, they secure the *kraya* i.e. the purchase of soma juice.

They may involve making a small hole in the bark and inserting a small tube into it. The tube is then sealed with a plug of mud or wax. The insect then inserts its head into the tube and sucks out the honey.

proper position of the half-month and the months also. They rise in the

...and the fact that the same persons are prosperous and successful in all respects."

This passage also occurs in the *Tāndya Brāhmaṇa* (5. 9) of Sāma Veda.

It, however, contains a few different words and one or two different

• **SPATIUM**

above passage. They only mean the full moon nights associated with the

stars Phalguni and Citra. It should be noted that neither the words.

[illegible][illegible][illegible]

11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841. 842. 843. 844. 845. 846. 847

11 111111 111111

"...and I think it's important to have a good understanding of the science behind the water before taking any action," he said.

[illegible]

"Fire should not be kindled on the Purva Phalguni nights ; (since) Purva Phalguni is the last night of the year. It should be kindled on the Uttara Phalguni. This is the first night of the year."

Although the word 'full moon night' is not explicitly mentioned here, still the full moon night when the Purva Phalguni stars come together with the full moon, appears to be implied in it. That the moon becomes full near the Phalguni nakṣatra is the idea suggested by these words. However, not only the word Phalguni does not occur in it, but even the word 'Phalguni-purnamasa' does not occur in it as it does in the lines quoted above from the Sāmhita.

The above lines show that the phenomenon of the moon becoming full near certain stars had been noticed in the times of Taittiriya Sāmhita and Brāhmaṇa. Still it must be remembered that the names Caitra etc., had definitely not come into vogue in those times.

एतत् १ वसन्तस्य प्रथमं तिथिं कालेति प्रथमम् ॥

शतपथब्राह्मण ३. २. १८.

कालेति प्रथमं तिथिं कालेति प्रथमम् । सप्तमं तिथिं कालेति प्रथमम् ।

प्रथमम् ॥

शतपथब्राह्मण ३. १९.

The words "Phalguni Purnamasa" occur in this. Even the *Sāṅkhyāyana Brāhmaṇa* (which the author has not seen) is said to contain the following line:—

एतत् १ वसन्तस्य प्रथमं तिथिं कालेति प्रथमम् ।

Any way, the word 'Phalguni' occurring in all these quotations only means "associated with the Phalguni star". The words 'Phalguni Purnamasa' occurring in *Saṭapatha Brāhmaṇa* (2-6-3) has been defined by Sayana as "that full moon night which becomes associated with the two Phalguni asterisms is known as the Phalguni". The *Samavidhāna Brāhmaṇa* (2.4) contains the line,

एतत् तिथिं कालेति प्रथमम् ।

शतपथब्राह्मण ३. २. ४.

In this 'Rauhiṇi' simply means "associated with Rohini star", it has nothing to do with the 'Rauhiṇi' month. Similarly, the Pausi, the Phalguni, etc., stand for those full moon nights which are associated with the stars of corresponding names. In short, it can be said that only the terms 'Phalguni' etc., had come into vogue at the time when Brāhmaṇa works were compiled. Nowhere in the Sāmhita and Brāhmaṇa do the words Phalguni, Caitra, etc., occur in the sense of names of months, and this shows that these terms were not then in vogue. Much time must necessarily have elapsed before the term Phalguni, Caitra etc., came into vogue, even when the terms Phalguni, etc., had gained currency. This point can be easily understood if one considers as to how long a time has to elapse before a scientific theory becomes an established truth.

In short, the terms Caitra, etc., were not in vogue in the Sāmhita and Brāhmaṇa period. Thus it can be proved from the historical point of view that these terms came into use after a very long period of time after the terms Madhu, etc., became current.

It will now be shown that even the Nature works in the same order of development.

In the beginning, man must have been guided by the moon for counting the months; and the cluster of stars situated in the path through which the sun and the moon are generally seen to move, must have received the names of 27 stars. But the position of the stars remains practically constant in relation to the ecliptic and, therefore, even after the names Madhu, etc., had come into vogue and the 27 nakṣatras had received special names, a considerable period of time must have elapsed; firstly, before it was minutely observed that the moon moves through particular groups of stars and that it becomes full near some of them and secondly, before the terms (Caiti Paurṇimā, etc.) came into vogue on the basis of that observation and thirdly, the terms Caitra etc., finally arose therefrom and became current as the names of months.

For instance, the star Aldebaran (Rohini) lies about $5\frac{1}{2}^{\circ}$ to the south of the ecliptic and must have remained in that position for thousands of years, but the moon does not move exactly on the ecliptic. It attains a position with maximum latitude of 5° to $5\frac{1}{2}^{\circ}$ north or south of the ecliptic. Had the points of intersection, that is, the moon's nodes (Rāhu and Ketu) been stationary, its position relative to the stars, would have remained unchanged; but the nodes have got motion. They make a complete revolution in about 18½ years. It is on account of this that the moon and the star Rohini at times come together in the course of 18½ years. Sometimes the moon occults the star while sometimes it is seen to be at a distance of about 11° of latitude from it. The phenomenon of the moon sometimes occulting a star and sometimes remaining away from it at a latitude of about 11° , is no mean source of confusion in one's attempt at detecting the rule about the occurrence of the full moon near the stars. It is in fact much more confusing and to add to this, there is another kind of minor confusion. For instance, during the period from September 1884 to March 1888, the moon regularly used to occult the star Rohini (Aldebaran), once in the course of every revolution and this phenomenon was observable at one place or the other on the earth. But it was not that every such occultation of Rohini occurring during the revolutions of the moon would be seen at a given place on the earth. This interesting phenomenon could be seen in our province only on 3 or 4 occasions. On other occasions this phenomenon used to take place sometimes by day or sometimes when the moon was below the horizon. On some occasions, the moon used to appear only at a very short distance from Rohini. Moreover, this position is not necessarily true in the case of all stars. In other words, the moon does not necessarily occupy a distance* of $+5^{\circ}$ maximum latitude from each star in each revolution of the node; for it sometimes comes very near to some stars and goes away from others; it moves via north in the case of some, and passes in a southerly direction in the case of others. Other kinds of confusion involved in perceiving this phenomenon of the full moon near the stars and formulating a rule about it are also worth noting.

For instance, if the moon becomes full near a particular star in the first month, it will become full again near the next second or third star in the

*This point cannot be fully discussed here. One can understand this by noting the moments of its conjunctions with the stars during any period of 5 to 7 years, as given in the tables on the lunar conjunctions with stars in the Sāyana almanac.

next month. The rule about the full moon's proximity with certain stars would be easily discovered, if after the completion of 12 lunar months the moon becomes full near the same star in the second round of 12 months as in the first.

But it so happens that if it is found to be full near, say, Āśvini, in the first month of the first round, it would appear to have become full near Revati in the first lunar month of the second round. It is also not true that the moon becomes full only near those 12 asterisms to which Citra and other lunar months owe their origin. As a matter of fact, it becomes full near each of the 27 asterisms in some month or the other. There is still another difficulty; there are only four out of the 27 stars which do not fade but remain visible even when the full moon is in close proximity with them, and they are Maghā, Jyēsthā, Citrā and Rohini. Some of the rest become invisible when the moon approaches them within a distance of 7° to 8° and there are still others which fade away in the moon's lustre when it is still further away. In short, it is obvious that long time must have elapsed before the rule about the moon's becoming full near particular stars could be established after the asterisms received their names. The next stage was the application of the names Citrī, Vaiśākhī, etc., to the full moons, and the stage next to this was the naming of lunar months after the stars.

In short, it is proved, from the natural order of progress and from the historical point of view, that the terms Citra etc. came into vogue when considerable time had elapsed after the introduction of names like Madhu, etc.

The Solar Months

References to the civil and lunar months are definitely found in the Vedas; but an explicit mention of solar months is not found anywhere in them. The solar month is the time which the sun takes to cross each of the 12 equal divisions of the 'bhacakra' (zodiac). Mēṣa and other names of Rāśis are not found in the Vedas; but that is immaterial. But even a corresponding set of names for the 12 equal divisions of the 'bhacakra' are also not found anywhere. Now, it cannot be said for certain that Madhu-Mādhava given in the Vedas as names of months were not the names of solar months for, while their connotation indicates some relationship with the seasons, that is indirectly with the sun, they are also used as synonyms for the seasons (see page 18). We do not, however, find any statement that they ended on days other than the full moon or the new moon days. On the other hand, we find it definitely mentioned that months end either on the full moon day or the new moon day. Hence, these appear to be the names of lunar months or in other words of the months which end on full moon or new moon days. The year, however, was undoubtedly solar, hence why should it be considered improbable that solar months different in measure from lunar months were also in vogue? In all probability, they were in current use and there are grounds to believe that just as Madhu and other names were applied to lunar months they were equally applicable to solar months also.

The Āmānta and Pūrṇimānta Months

Let us now see if the months were Pūrṇimānta or Āmānta. That month which ends with Āmāvāsya or the new moon is called Āmānta and the one which ends in Pūrṇimā or the full moon is called Pūrṇimānta. Both these

modes of reckoning are found in the Vedas. That (night) on which the Masa (month) becomes *pūrṇa* (full or complete) is *Paurṇamāsī*. Hence, the very word *Paurṇamāsī* indicates the *Pūrṇimānta* reckoning.

शुक्ल पौर्णमासी शुक्लपौर्णमासी ॥

शु. सं. १. ३. ७.

"Religious vow is commenced with a sacrifice on the full moon day and with calves on the new moon day".

In this quotation the word coupled with 'Amāvāsya' is *Pūrṇamāsa*, which shows that the month used to become full on the *Paurṇamāsī* day.

The following quotation from a stanza in "*Uisargināmayana*" shows that the months* ended both on *Amāvāsya* and *Pūrṇimā* :—

अमास्यामासां पौर्णमासी अमास्यामासां पौर्णमासी ॥
मासां पौर्णमासीमासां पौर्णमासी ॥

शु. सं. १. ३. ७.

The following lines immediately following the above stanza specially appear to favour the *Pūrṇimānta* system :—

यत् शुक्ल पौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी
शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी
शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी
शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी ॥

शु. सं. १. ३. ७.

In the chapter on 'Universe' in the *Ātharvashūk*, the description of the 'Creation of Sāhvāsara' is followed by these lines referring to the month and the half-month :—

मासी शुक्लपौर्णमासी शुक्लपौर्णमासी शुक्लपौर्णमासी ॥

"The month is verily the *Prajāpati* ; its dark half is the Sun and the light half the Life (soul)."

In this, the dark half is mentioned first ; this shows that the *Pūrṇimānta* system was in vogue. But the *Taittirīya Brāhmaṇa* gives the list of names of days in the two halves of a month (see page 43) ; the list gives the names of days in the light half first and those in the dark half afterwards ; this leads one to believe that even the *amānta* system was in use.

THE PŪRVA AND THE APARA HALF

If the *Pūrṇimānta* system be adopted, the dark half of the month comes first and the light half afterwards, and hence, the term 'pūrva' should have

*The *Kāṇvaśūk*, after considering the doubts raised against these quotations, has given the verdict that these lines describe both the *pūrṇimānta* and the *amānta* systems.

been applied to the dark half and 'apara' to the light one; but it is not so. The 'pūrva-apara' terms are applied respectively to the light and the dark half.

पूरुवा अपरा इति नाम्ना द्वौ पक्षौ च । पक्षौ च ॥

श्रु. श्रु. ३. १०. १.

"Gods were born in the 'pūrva-pakṣa' and the demons (asuras) in the 'apara-pakṣa' that is why the gods won and demons were defeated."

पूरुवापक्षाः ॥ अपराः पक्षाः ॥

श्रु. श्रु. ३. १०. ४. १.

"The pūrva-pakṣa is the girdle and the apara-pakṣa is the dirt".

Although the terms light and dark are not explicitly mentioned, the fact that 'Sukla' indicates something auspicious and 'Kṛṣṇa' something inauspicious, one may presume that the term 'Pūrva-pakṣa' stood for 'Sukla' and 'apara' for 'Kṛṣṇa'. The names of the 15 days of each of the 'Pūrva' and 'Apara' halves are given later on, and the terms 'Pūrva' and 'Apara' have been used in the sense of 'Sukla' and 'Kṛṣṇa' in them. In the 'Nirukta' (11.6) it is said in the *mantra* concerning the moon,

पूरुवा पक्षा इति पक्षौ च । पक्षौ च ॥

पूरुवापक्षाः ॥

The word 'Pūrva-pakṣa' has clearly been used in the sense of 'Sukla-pakṣa' and the 'Apara-pakṣa' in the sense of 'Kṛṣṇa-pakṣa'. The words 'pūrva-pakṣa' are found used in this very sense in the post-Vedic works.

THE DAY

Let us now consider the civil day, the solar day and the lunar day (*i.e. tithi*). The solar month does not explicitly occur in the Vedas and hence, it is clear that the solar day also was not in vogue. One expects the civil day to be mentioned in the Vedas and so it is. It is very convenient for civil purposes. Quotations have already been given showing that the sacrifices were performed with respect to civil days.

Names of Days

The Taittiriya Brāhmaṇa gives different names for the days and nights in the light and dark halves of the month. They are:—

रात्रिः पक्षे रात्रिः पक्षे ॥ पक्षे रात्रिः पक्षे ॥

पक्षे रात्रिः पक्षे रात्रिः ॥ पक्षे रात्रिः पक्षे रात्रिः ॥

श्रु. श्रु. ३. १०. १.

The 'anuvāks' (stanzas) mentioned here are given in the same Brāhmaṇa in one 'anuvāk' at a different place. They are:—

रात्रिः पक्षे रात्रिः पक्षे ॥ रात्रिः पक्षे रात्रिः पक्षे ॥

पक्षे रात्रिः पक्षे रात्रिः ॥

श्रु. श्रु. ३. १०. १.

These are the names of the days (excluding nights) of the 'Purvatpakṣa'. They are 15 in number mentioned in groups of five in each line.

एतौ द्वादशैः पक्षेण पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

अथपञ्चमः पक्षः पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

तै. श्र. ३. १०. १. १.

This is a list of the names of 15 nights of a 'Purva-pakṣa' which stands for the light half as is suggested by the word 'Purnamāsi' etc. occurring in it.

अथपञ्चमः पक्षः पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

अथपञ्चमः पक्षः पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

तै. श्र. ३. १०. १. १.

These are the names of the 15 days in the 'Apara-pakṣa' or the dark half.

अथपञ्चमः पक्षः पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

अथपञ्चमः पक्षः पुरातनः ॥ अथपञ्चमः पक्षः पुरातनः ॥

तै. श्र. ३. १०. १. १.

These are the names of the 15 nights in the dark half. The names of days given in the list are used in the neuter gender while those of nights are in the feminine. It appears that because the word 'ah' meaning 'a day' has the neuter gender, the names of days are in neuter gender and because the word 'rātri' (night) is in the feminine, the names of nights are also in the feminine gender.

The above line gives 'Kāmadughā' and not 'Amāvasyā', as the name of the last night of the dark half. The last night of the light half is however indicated by the word 'Purnamāsi' itself.

The above lines and the references at other places show that Purnamāsi and Amāvasyā are the qualifying adjuncts of 'night' and not of 'tithi'. The words amāvasyā and purnamāsi occur quite frequently in the Taittiriya Samhitā and the word 'tithi' does not occur at all. Hence, the two words cannot possibly indicate a 'tithi'.

TITHI

Nowhere in the Vedic literature the author came across the word 'tithi' in the sense of the 30th part of the lunar month or the time required by the moon to gain 12° of longitude on the sun. Even though the month is lunar, its 30th part will be shorter than the civil day, because its length is about 29½ civil days. Hence, the mean length of the tithi is shorter than a civil day and there is no easy and natural means to measure it, and on account of this we do not get in the Vedas either the true or the mean tithi in its modern sense. The word tithi occurs in the *Baṅgīca Brāhmaṇa* at some places and the definition of the tithi as given at one place is,

यः पक्षस्तथा तथैव तथैव ॥

तै. श्र. ३. १०.

"Tithi is that period of time during which the moon sets and rises again". The interval between two consecutive moonrises is longer than a civil day by about a "muhūrta" (i.e., 48 minutes). The sun rises 29 or 30 times during a lunar month and the moon rises 28 or 29 times. Hence, 30 tithis according

to the above definition will never occur in a lunar month. We do not get this definition in other Vedas or post-Vedic literature. This shows that this definition was not much in vogue. It may be that the true import of the definition was different. In any case, the 'tithi' in the astronomical meaning and 'pratipad' and other tithis are found nowhere in the Vedas. But Pūrṇimā and Amāvasyā are denoted by the word "Pāñcadaśī" meaning 15th.

पञ्चादशैः पञ्चादशैः ॥ पञ्चादशैः ॥ पञ्चादशैः ॥

त. म. १. ५. १०.

"The moon wanes on the Pāñcadaśī night. (She) becomes full on the Pāñcadaśī night".

Since the term Pāñcadaśī has occurred in the sense of 'fifteenth', other terms, such as Pratipad, Dvitiyā, etc., must have been in use to denote the first night, the second night etc. In the beginning, these must have been used to denote the nights and afterwards the tithis. The terms Kṛṣṇa Caturdaśī, Kṛṣṇa Pāñcadaśī, Sukla Caturdaśī, have occurred in the *Sāma Vidhāna Brāhmaṇa* (see 2, 6; 2, 8; 3, 3).

Asṭakā

We come across the term 'asṭakā' somewhat similar to amāvasyā and Pūrṇimā. The following line may be seen :—

अष्टादशैः ॥ अष्टादशैः ॥ अष्टादशैः ॥

त. म. १. ५. ११.

"The full moon nights are twelve, the asṭakās are twelve, the new moon nights are twelve".

A sentence similar in meaning is found even in the *Satapatha Brāhmaṇa* (6.4.2.10). From this it appears that just as 12 full moons or 12 new moons occur in one year's time, so also 12 asṭakās occur in one year. The number occurring during the year is said to be 12 and not 24. From this it appears that 'asṭakā' might be the term applied to the 8th night, either of the light half or of the dark half of the month. The word asṭakā comes after the word Pūrṇimā in the above line. It occurs similarly in the following line :—

अष्टादशैः ॥ अष्टादशैः ॥

त. म. १. ५. १२.

From this it seems that the 8th night in the dark half of the month must have been termed 'asṭakā'. This has been explicitly stated in the *Asvalāyana* and other Sūtras :—

अष्टादशैः ॥ अष्टादशैः ॥ अष्टादशैः ॥

त. म. १. ५. १३.

In this, the 8th night of the dark half is termed 'ekasṭakā'. The *Āpas-tamba Sūtra* applies the term 'ekasṭakā' to the 8th night after the Māghī Pūrṇimā.

Vyastakā and Udrisṭa

अष्टादशैः ॥ अष्टादशैः ॥ अष्टादशैः ॥

अष्टादशैः ॥ अष्टादशैः ॥ अष्टादशैः ॥

त. म. १. ५. १४.

These sentences occur also in the *Tāndya Brāhmaṇa* (18.11.8). According to these lines 'Vyaṣṭakā' was the 1st night of the dark half of the month and Udyṣṭa, the 1st night of the light half.

THE MOON'S PHASES

In the Vedas we come across the belief that the phases of the moon increase and decrease because they are drunk by the gods.

यदा देव मधुमा नम अमृतम गतः ॥ तदाः मीनस्य मीनानि ममम अमृतमः ।

म. सं. १०. २५. ५.

"Oh Moon ! The gods drink you, but later on you become bright again. The wind is the protector of the moon. Thou art the maker of *samas* (i.e. years), and of the months."

This 'richā' is construed in the Nirukta, as applicable to the 'soma' plant as well as the moon.

मममृतम मीनममृतम मीनममृतमः मममृतमः ।

म. सं. १. ४. १४.

"The suns make her bright, and when she is full, they drink (devour) her."

The word sun is used here in the plural. It must have been so used to denote the 12 suns of the year. This shows that in the beginning it was perhaps the belief that it was the sun who brings about the increase or decrease of the phases. Afterwards when the word '*āditya*' began to denote 'gods', the belief that gods devour the moon must have arisen.

MOON'S LIGHT

The following line states in clear terms that the moon receives light from the sun :—

सूर्यादिरस्य मयः ॥

म. सं. ३. ४. ७. १.

The moon is here spoken of as 'Sūrya-rasmi', that is the one who receives rays of light from the sun.

WHERE DOES THE MOON DWELL ON AMĀVASYĀ DAY

The following lines express the belief that the moon is seen nowhere in the sky on the new-moon night, because she comes to earth and enters the medicinal herbs.

मीमांसायाः रीतिरस्य मीमांसा मयः मयः मयः मयः ॥

म. सं. १. ४. ३. २२.

एव मीमांसा रीति मयः मयः मयः मयः मयः मयः मयः मयः ॥

मीमांसा रीति मयः मयः मयः मयः मयः मयः मयः मयः ॥

मयः मयः रीति मयः मयः मयः मयः मयः मयः ॥

together on the amāvasyā day:—

ब्रह्म आत्मवस्तुवर्तिरयमन्यथावर्तिनः... अतिरथाह ब्रह्म ज्ञानम् ।

20. 12. 81.

born of the sun,

appearance in the evening of the 1st day of the light half.

DARŚA, PARVA, ANUMATI, etc.

denoting some details also.

या पूर्वार्धे पूर्वाभासो सात्त्विकयुक्तः सः राक्षः यः पूर्वभासात्मा सः सिद्धिबालो योग-

पृष्ठ १५५ :

१५. ३२. १०. ११. ३. १०.

“Kuhny.”

—: sɐʌɪssqo

॥ यन्मन्त्रोवाच कर्तव्यं देवपुत्रं यन्मन्त्रोवाच ॥

ମି. ଶ୍ରୀ. ଶ୍ରୀ. ଶ୍ରୀ.

of gods ; but according to the sacrificers they are simply new moon nights."

MOTIONS OF THE SUN AND THE MOON

The amāvaśyā's and pūrṇimā's occupy an important place in the Vedic literature in respect of sacrifices. It was the sacrifices performed on the new moon and the full moon days which were, beyond doubt, responsible for such researches as were made in the Vedic age, as those relating to the motions of the luminaries but not described in the Vedic literature for want of suitable occasions—researches which gradually developed into the Vedāṅga Jyotiṣa. The Vedic conjunctions like '*Sandhanu yajeta*' or '*sandhimabhito yajeta*' (i.e. one should perform a sacrifice at or near the 'junction' of a parva) suggest that attempts must have been made to find out when the 'parva-sandhi' occurred and they must have attained some knowledge about it.

*The Matsya and Vāyu Purāṇas speak of "darśa" as follows:—

Aranya tannavasyaṃ pashyan susamagataḥ. Anyaṃ caṇḍarāyaṇaṁ yada tadāśya ucyaṭe meaning when the Sun and the Moon meet and stay together on the Arṇavaśya day and keep gazing at each other, that moment is termed 'darsa'. This shows that the phenomenon of the moon and the sun coming together was well known to Purāṇas also.

The *Āturiya Brahmana* also gives a very similar description (see 1, 2, 4). In addition to the idea of the equinox occupying the central position, it contains other notions also relating to the sun's high or low position in the sky.

ᐅᐅ ᐱᐱ ᐱᐱ ᐱᐱ

The Taittiriya Brāhmaṇa also gives a similar description in the following lines :—

१७. १८. १९. २०. २१.

Nowhere in the Vedas do we find a reference explicitly defining *viśvān* as that day on which the day and night are of equal length. It simply means an interlude occurring in the course of the 'sātra' or 'śaḍaḥas', no matter whether the 'sātra' continued for the whole year or for only a few days (see the *Tāndya Brāhmaṇa* 13.4.16 and the commentary thereon by Śāyanaśāstrīya). There are only two equinoctial days in the year on which the days and nights are of equal length, and if the annual sacrifice is commenced on one of them, the second equinox will come in the middle of the sacrifice (sātra).

These are the names of the 15 muhurtas of the night* in the light half.

सविता सविता सविता सविता सविता ॥ सविता सविता सविता ॥

सविता सविता ॥ सविता सविता सविता सविता सविता ॥

स. म. ३. १०. १. २.

These are the names of the 15 muhurtas of the day in the dark half.

अश्विनः सविता ॥ अश्विनः सविता ॥ अश्विनः सविता ॥

सविताः सविताः सविताः सविताः सविताः ॥

स. म. ३. १०. १. ३.

These are the names of the 15 muhurtas of the night in the dark half.

The whole day and night together must have been divided into 30 divisions, just as the month is divided into 30 parts. The post-Vedic works do mention muhurtas as parts of the day, but they do not mention the names as given above; the muhurtas are found to receive different kinds of names.

THE SUB-DIVISIONS OF MUHURTAS

Each muhūrta is supposed to be sub-divided into very small equal sub-muhūrtas (15 in number).

अथ यद्वि ॥ सविता सविता ॥ सविता सविता ॥ सविता सविता ॥

स. म. ३. १०. ३. ३.

"The muhurtas are further divided into sub-divisions called pratinuhūrtas; their names being *Idānim*, *Tadānim* and others."

The "pratinuhūrtas" are given below:—

सविता सविता ॥ सविता सविता ॥ सविता सविता ॥

सविता सविता सविता सविता सविता ॥

KALĀ AND KĀṢṬHĀ

स. म. ३. १०. १. ४.

सविता सविता ॥ सविता सविता ॥ सविता सविता ॥

सविता सविता सविता सविता सविता ॥

सविता सविता सविता सविता ॥

This line from the *Nāradyana Upaniṣad* mentions "Kālā and Kāṣṭhā" as units of time in addition to the muhurtas; and one cannot make out their mutual relation or their relation with other units of time. The remaining parts of the day known as ghaṭis and palas are nowhere to be found in the Vedas.

NAKṢATRAS

Let us now consider the nakṣatras. A few lines from *Rk Saṁhitā* are given below which contain references to nakṣatras, that is, not to particular

*This is obvious from the context.

In this, 'fca' the word Arjuni has been used in the sense of Phalguni and 'Agha' in place of 'Magha'. These words are mostly absent in the post-Vedic literature; there is, however, no doubt that they denote the nakṣatras mentioned, because a variant of this very 'fca' appears in the Atharva Saṁhitā as given below.

३३. ४. ४. ४. ४.

ॐ नमो भगवते वासुदेवाय ॥ ॐ नमो भगवते वासुदेवाय ॥

This clearly shows that Arjuni is identical with Phalguni. In the Yajur-Veda, the word Maghā is used as 'Maghāsū' in plural feminine form so is Aghāsū used here. Similarly, 'Arjunoḥ' has been used like 'Phalgunyoḥ' in the feminine dual form. Two acts are said to have occurred here in succession just as Maghā and Phalguni appear in succession*. This order and the gender and number of Aghā and Phalguni, agree with those given by the Taittiriya Veda and post Vedic astronomical works. This proves beyond all questions that the nakṣatra system described in the Yajur-Veda was fully in vogue in the Rīgvedic times.

॥ श्री गुरुभ्यो नमः ॥

शेषस्य विरः संप्रत्यक्षवर्तनः प्राणवर्धनः शीघ्र विद्याः पारा अर्वाचारविद्याः

पञ्चवर्गैर्यत्र त्रिसेवोषमासाः पर्वणि मासाः संवत्सरपूरणोऽस्ति

संवरसुत आरामा रक्षयः केशा वध्यानि खणं नारका अस्यानि वयो मासानि...॥

॥ श्री. ग. व. भ. श्री. ॥

“He who knows the head of the sacrificial horse becomes ‘Śiṛṣaṇvān’ and holy. The uṣā (dawn) is the sacrificial horse’s head. The sun is the eye, winds the life, moon the ears, the (four) quarters the legs, other quarters are the ribs; the day and night represent the winking of the eyes, the half-months are knuckles and the months are the sandhāna (joints); the seasons are the limbs, the year is the soul, the sun beams are the hair, nakṣatras the form and the stars are the bones”.

*The words "aryamah"....."asat" occurring in the passage cited on the next page are worth considering.

The following anuvak from Lalitraya Samhita mentions all the nakṣatras :—

अने: कृति का: ॥ गुरुं परस्माद्विगीतवत्ताने ॥ प्रजापते रीद्विणी ॥ आप: परस्माद्विष-
यवीवत्ताने ॥ सीमापुंस्वका विवर्तिन ॥ परस्मात् पयनीवत्ताने ॥ वदस्य वीरे ॥ मांयव:
परस्माद्विषयरीवत्ताने ॥ अदिस्य पुनर्वसु ॥ वात: परस्मादादम्बवत्ताने ॥ वृहस्पतीरित्यु: ॥
भृक्षत: परस्माद्विजमाना अवत्ताने ॥ सपत्निगाम्येव: ॥ अयथागच्छत: परस्माद्विआन्यन्येव-
त्ताने ॥ विप्रणी सवत: ॥ ऊर्ध्वत: परस्माद्वपञ्चवीवत्ताने ॥ अपङ्ग: पूर्व फल्गुनी ॥ जामा
परस्माद्विषयवीवत्ताने ॥ मास्मात्परे ॥ वदन्व: परस्माद्विगमाना अवत्ताने ॥ वैवस्व सविश्व-
द्वेत्त: ॥ प्रवव: परस्माद्विगीतवत्ताने ॥ इन्द्रस्य विजग ॥ शूनं परस्माद्विषयमवत्ताने ॥
वायीर्निष्कृया ववति: ॥ परस्माद्विषयिद्विद्वत्ताने ॥ इन्द्राग्निप्रीतिशब्दे ॥ पृथगिनि परस्माद्विषय-
माणा अवत्ताने ॥ विश्वत्यागुरत्या: ॥ अयथारीद्वि: परस्माद्विआन्यन्यवत्ताने ॥ इन्द्रस्य रीद्विणी ॥
माणा अवत्ताने ॥ निमृष्टस्य मूलवर्हेणी ॥ प्रतिभञ्जत: परस्माद्विगीतवत्ताने ॥
अथ पूर्व अवाडा: ॥ वव: परस्माद्विषयिनिद्वत्ताने ॥ विश्वेवषा वैधानामृषा: ॥ अग्निमज्ज-
परस्माद्विगीतवत्ताने ॥ विष्णो: श्रीणा पञ्चमाना: ॥ परस्माद्विषय अवत्ताने ॥ वषट् ॥

In this we have descriptions of the nakṣatras, which are all of this pattern. "The Kṛttikās belong to Agni; Śukra is on the other side, and Jyoti is on this side." The rationale and purpose of describing nakṣatras as having one thing on this side and another thing on that side are not fully understood. It appears that the things mentioned here are in reference to the benefic and malefic results relating to nakṣatras in some cases and to their forms in some others. The lines referring to Phalguni in this passage is very similar to the facta quoted from the Rgveda above. Again, the sentence 'Mātirya Kṛt-gāne' meaning fields should be ploughed on Anurādhā nakṣatra has been quoted further on.

The reason for this direction perhaps lies in the fact that the preceding nakṣatra Viśākha has the yoke of the plough on that side, and ploughmen on this side. The words 'yoke' and 'ploughman' appear to have some relation with the figure of the nakṣatra.

The names of all the nakṣatras and their deities, and some quaint and interesting legends about the nakṣatras are found in the Taittirīya Brāhmaṇa Aṣṭaka 3, prapāṭhaka 1 and 2 but these anuvāks cannot be cited here for want of space. They do not specifically mention the deities of nakṣatras, but the relation of the deities with the nakṣatras is in some way suggested in such words as "agnir naḥ pāu Kṛttikāḥ". (May Kṛttikās and Agni protect us) "Ardraya Rudrah prādhānamāneri" (i.e. Rudra becomes famous on account of Ardra). Similarly, all the nakṣatras with their deities have been mentioned in the 4th and 5th anuvāks of the same 'prapāṭhaka'. These anuvāks are very lengthy. The lines about one nakṣatra, which will give some idea about the other nakṣatras, are quoted below:—

भृश्वरिषी अमृत्यु ॥ भृश्वरिषी स्याति ॥ स एव भृश्वरिषी स्यात् नरारं चरं
 पृथिविरप्यत ॥ नरी च स भृश्वरिषी चरं ॥ भृश्वरिषी च स भर्ता ॥ स एवैव हिमरा
 पृथिविरप्यत ॥ स उ चरं चरं ॥ सौम्यं स्याति ॥ भृश्वरिषी स्यात् नरारं चरं ॥ भृश्वरिषी
 सप्त स्याति ॥

त. श्र. ३. १. ४. ६.

"Bṛhaspati wished to be holy through spiritual knowledge. He offered to Bṛhaspati and Tisya (Pusya) a 'charu' (oblation) of 'nīvar' (rice) in milk. Because of this he became holy. He who offers this oblation in a sacrifice and understands it becomes holy; while offering the oblation he chants the mantra 'An offering to Bṛhaspati, an offering to Tisya, an offering to holy-men'.

The nakṣatras and their deities have thus been mentioned in four places. These, together with their gender and number have been shown in one table on page 48 to 50. The differences, if any, regarding the names and deities of nakṣatras have been indicated by numbers 1, 2, 3, and 4 which denote in succession the four places in which they occur. No numbers are given to those nakṣatras about which there is unanimity in all the four places. The word-ing of the anuvāks from the Taittirīya Sāmhitā shows that the genders and numbers of nakṣatras mentioned in it are the same as those given in other places. The nakṣatras mentioned by Atharva Sāmhitā are as given in the following lines:—

तैत्तिरीयः सप्त स्याति सप्तैश्वरिषी सप्तैश्वरिषी सप्तैश्वरिषी ।

अथर्वः सप्तैश्वरिषी सप्तैश्वरिषी सप्तैश्वरिषी सप्तैश्वरिषी ॥ १ ॥

| No. | Name of Nakṣatra | The controlling Deity | Gender | Numb. of |
|-----|---------------------|-----------------------|-----------|----------|
| 1 | Kṛtikā | • Agni | Feminine | Plural |
| 2 | Rohiṇī | • Prajāpati | " | Singular |
| 3 | (1, 3, 4) Mṛgaśīrṣā | • Soma | Neuter | " |
| | (2) Invakā | " | Feminine | Plural |
| 4 | (1, 3, 4) Ārdra | • Rudra | " | Singular |
| | (2) Bāha | " | Masculine | Dual |
| 5 | Punarvasu | • Aditi | " | " |
| 6 | Tīṛṭṭā | • Bhṛaspati | " | Singular |
| 7 | Āśleṣā | • Sarpā | Feminine | Plural |

Nakṣatras mentioned by the Taittirīya Sṛuṭi:—

"I being desirous of welfare, worship the heaven with speeches, because 28 clusters of stars, like wonderful illuminating lights arranged in the form of nimble serpents, shine in the sky" (1st verse).

These lines do not mention any deities for the nakṣatras, and as the first mantra shows, the nakṣatras appear to be 28 in number. The Taittirīya Sṛuṭi has mentioned Abhiṣit nakṣatra in two out of four places; but nowhere does it mention whether the nakṣatras are 27 or 28. The Śatapatha Brāhmaṇa has stated at one place (10-5-45), that the nakṣatras are 27 and Upanakṣatras are 27. The above lines from Atharva Saṁhitā appear to have used the name Kṛtikā in the singular number. The Mṛgaśīrṣā and Puṣyā are mentioned as Mṛgaśīrṣā and Puṣyāḥ (in masculine gender), the word Svātī has been used as Svātī ending short i, and appears to be masculine. The name Anurādhā has the second vowel short and is used in the singular number. The word 'Sṛavaṇa' has been used (in place of Sṛoga) while the name Bharaṇi is changed to Bharaṇyāḥ. These are the points of difference between the Atharva Saṁhitā and Taittirīya Sṛuṭi; but otherwise the two works show an agreement. The genders and numbers of some of the nakṣatras cannot be clearly ascertained, but one may presume that they are the same as in Taittirīya Sṛuṭi. There is, however, some doubt about the Proṣṭhapada. The words "Victian nāma idrake", occurring at some places (2. 8. 1; 3. 7. 4) appear to refer to the nakṣatra Mūla.

अथ. सं. १६. ७.

गुह्यं ये शिवान् रक्षिष्वं वासु नमः शिवायः शान्तिः ।
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ १ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ २ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ३ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ४ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ५ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ६ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ७ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ८ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ ९ ॥
 गुह्यं गुह्यं वासु नमः शिवायः शान्तिः शान्तिः ॥ १० ॥

| No. | Name of Nakṣatra | The controlling
Deity | Gender | Number |
|-----|------------------------|--------------------------|-----------|----------|
| 8 | Magha | • • • | Feminine | Plural |
| 9 | (1, 3, 4) Phalguni | • • • | " | Dual |
| | (2) Phalguni | • • • | " | " |
| 10 | (1, 3, 4) Phalguni | • • • | " | " |
| | (2) Uttara Phalguni | • • • | " | " |
| 11 | Hasta | • • • | Masculine | Singular |
| 12 | Citra | • • • | Feminine | " |
| | (1, 2) Indra | • • • | " | " |
| | (3, 4) Tvāṣṭā | • • • | " | " |
| 13 | (1) Svāti | • • • | " | " |
| | (2, 3, 4) Nītyā | • • • | " | " |
| 14 | Viśākhā | • • • | " | Dual |
| 15 | Anurādhā | • • • | " | Plural |
| 16 | (1, 2) Rohiṇi | • • • | " | Singular |
| | (3, 4) Jyēṣṭhā | • • • | " | " |
| 17 | (1) Vicrta | • • • | Masculine | Dual |
| | (2) Mula Baharṇi | • • • | Feminine | Singular |
| | (3) Mula | • • • | Neuter | " |
| | (4) Mula | • • • | " | " |
| 18 | (1, 3, 4) Aśādhā | • • • | Feminine | Plural |
| | (2) Pūrvaśādhā | • • • | " | " |
| 19 | (1, 3, 4) Aśādhā | • • • | " | " |
| | (2) Uttaraśādhā | • • • | " | " |
| 19A | (3, 4) Abhijit | • • • | Neuter | Singular |
| 20 | Śrōṇā | • • • | Feminine | " |
| 21 | Śravīṣṭhā | • • • | " | Plural |
| 22 | Sataviṣāk | • • • | Masculine | Singular |
| | (3, 4) Varuṇa | • • • | " | " |
| 23 | (1, 3, 4) Proṣṭhapada | • • • | " | Plural |
| | Ajākapād | • • • | " | " |
| | (2) Pūrva Proṣṭhapada | • • • | " | " |
| 24 | (1, 3, 4) Proṣṭhapada | • • • | " | " |
| | Abhūdudnīya | • • • | " | " |
| | (2) Uttara Proṣṭhapada | • • • | " | " |

| Name of Nakṣatra | The controlling Deity | Gender | Number |
|------------------|-----------------------|----------|----------|
| 25 Revati | • • • • • Pūṣa | Feminine | Singular |
| 26 Aśvayujā | • • • • • Aśvin | " | Dual |
| 27 Apabharagī | • • • • • Yama | " | Plural |

The derivation of the word nakṣatra has been given by Taittiriya Brāhmaṇa in the following lines :—

प्रागुक्ता अन्वयार्थः ॥ तर्हिः ॥ अन्वयः ॥
 तर्हि अन्वयार्थः ॥ तन्मन्त्रः ॥ तन्मन्त्रः ॥

त. म. २. ७. १८. ३.

This, in short, appears to mean that those which are not 'Kṣatra' (movable) are Nakṣatras. The Nirukta, explaining that the term nakṣatra is derived from its quality of being *movable* and adds that according to the Brāhmaṇas the nakṣatras are so called because they are not 'Kṣatra' (i.e. movable). The Taittiriya Brāhmaṇa at another place writes as follows :—

तस्मात् तन्मन्त्रः ॥ तन्मन्त्रः ॥ तन्मन्त्रः ॥
 तन्मन्त्रः ॥ तन्मन्त्रः ॥ तन्मन्त्रः ॥
 तन्मन्त्रः ॥ तन्मन्त्रः ॥ तन्मन्त्रः ॥
 तन्मन्त्रः ॥ तन्मन्त्रः ॥ तन्मन्त्रः ॥

त. म. १. ५. २.

"There was water in the centre. The tāraṁ (stars) are said to possess the property of tāraṁ (protectiveness) because they floated and saved themselves. He who performs a sacrifice here goes (nakṣatra) to that world. Hence is the 'nakṣatra' significantly so called. They are the houses of gods. He who knows this becomes the owner of a house. The nakṣatras are the images of the earthly objects. Hence a rite should not be allowed to terminate and a sacrifice should not be performed on an ugly nakṣatra ; it gives the same result as a rite performed on an inauspicious day".

These lines are very important as the derivation of the word *tāraṁ* appears more to be quibbling, but the second derivation which traces the word to the root "nakṣa" (to go) and the notion that the virtuous in this world should ascend the heaven and become nakṣatras, is noteworthy. Several nations of the world might be cherishing this belief. The idea that the nakṣatras are houses of gods is very important. Here, what can the word 'deva' stand for other than the shining planets, actually moving through the stars? The notion that the nakṣatras are the houses (*grhas*) of gods suggested the derivation that what holds (*grhṇāti*) a house is a (*graha*) planet and thus the word *graha* (planet) seems to have been applied to resplendent gods like Venus etc.

Looking to the derivation of the word nakṣatra that they are the images or pictures of the earth or earthly objects, it appears that the nakṣatras must have derived their names from their resemblance to particular figures. But some nakṣatras seem to have received their names for other reasons.

standing of the pakṣata names:—

३३०४.५.३३.

in the dual form like the star-name Punarvasu.

५. ५०. ०. ५. ५.

ଶ୍ରୀ. ଶ୍ରୀ. ଶ୍ରୀ. ଶ୍ରୀ. ଶ୍ରୀ.

charity.

may be seen for this sense:—

ନିକଟତମ ୧.୭.

ፌ.ዲ.ሪ.ህ.ዲ.ፌ.

३. ६७. ३. ५. ३.

some other nakṣatras also.

the reasons for these appellations and hence it is given below :—

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“Prajāpati felt love for his own daughter—the sky, some say, the ūṣā (dawn) others. She became a *rohini* i.e. a deer. He became a ‘*śya*’ (a white footed antelope) and went up to her. The gods saw him and (began to remark) ‘Prajāpati is now doing a deed improper’. They sought one who would punish him ; but they did not find any one among them. Then they brought together in one place their most dreadful forms. Brought together, they became a deity, therefore his name contained the word *Bhūta*. He was then born who knows thus his name. To him the gods said, ‘Prajāpati here hath done a deed unknown, pierce him’. ‘Be it so’, he replied, ‘Let me choose a boon from you’. ‘Choose’ (they said). He chose this boon. ‘The over lordship of cattle’. Therefore does his name contain the word ‘cattle’. He who thus knows his name becomes rich in cattle. Having aimed at him, he pierced him, being pierced he flew upwards, him they call the ‘deer’. The piercer of the deer is he of that name (*Mṛgavyādha*). The female deer is Rohini. The (*Trikāṇḍa*) is the three pointed arrow.”

(λ-Orion) Migastirsa

Rohini
(Aldebaran)

West

East

Vyadha

(Sirius)

South

In this figure ten stars have been shown in the Orion group. The group of three stars appearing in a straight line and situated in the middle are known as *Trikāṇḍa Bāṇa* or three-pointed arrow. The four stars around it are the four feet of the antelope, and the small cluster of three stars to the north of all these stars is known as the *Migaśirsa* (head of the antelope).

Many more small stars can be seen near these stars in the sky. All these stars together are called the Orion by European astronomers. A look at all the stars in the figure will show that the stars Rohini, Miga and Migaśirsa must have derived their names from the figures of the star-groups. Again, when these clusters after having risen in the east, begin to move towards the west, it appears as if the Miga (the antelope) is chasing Rohini (the deer) and Vyādha (hunter) is chasing the antelope, and the legend of Rohini and Prajāpati might have been suggested by this scene.

The *Taittiriya Brāhmaṇa* (1. 1. 10) gives the legend of Rohini and Prajāpati in a slightly different form. The purport of the legend is :—

Prajāpati created 'prajā' (people). In so doing, the viraj (Universe) was created from his semen. Gods and demons received it. Prajāpati said 'She is mine'. She flew to the east. Prajāpati followed her. She thus ran for protection from place to place. In the end it is remarked :—

सि तत्र उवाचिदं ॥ सः प्रीत्ययत् ॥ नारीयं प्रीतिरत् ॥ प्रीत्ययत्तयत् ॥
तत्र पृथं योती प्रीतिरत्तयत् ॥ अतोयत् ॥

त. ब्र. १. १. १०. ६.

"She then ascended (the heaven). Hence, she came to be known as Rohini. She got this name Rohini, because she ascended heavenward. One should light fire on the 'Rohini' nakṣatra".

The star got the name Rohini because she ascended heaven. The origin of the word Rohini has been given at another place as follows :—

प्रजापति प्रीत्ययत्तयत् ॥ सः प्रीतिरत् ॥ नारीयं प्रीतिरत् ॥
नारीयं प्रीतिरत् ॥ प्रीत्ययत्तयत् ॥ अतोयत् ॥ सः प्रीतिरत् ॥

त. ब्र. १. १. २.

The *Taittiriya Brāhmaṇa* describes the origin of names of some other stars also as in the following verse :—

अरा वः यतः संतीत्ययत्तयत् ॥ अतोयत् ॥ अतोयत्तयत् ॥ तै
प्रजापतिरत्तयत् ॥ नारी वः यतः प्रीतिरत् ॥ यः पृथं यतः प्रीतिरत्तयत् ॥
स प्रजापतिरत्तयत् ॥ अतोयत् ॥ अतोयत्तयत् ॥ अतोयत् ॥

त. ब्र. १. १. २.

"The gods when in good condition desired to light sacrificial fire. (But) their fire remained unlighted, and because of this, their precious wealth left them. They commenced a sacrifice on Punaṛvasu nakṣatra. The wealth again came back to them."
Other ideas based on the words 'Punah' (again) and 'Vasu' (wealth) can be seen at two or three other places.

The origin of the names of Anurādhā, Jyēṣṭhā etc. has been described in the following lines :—

अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥
 अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥
 अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥ अनुराधा नमः ॥

॥ अ. १. ५. २.

Sāyana, while commenting on this, remarks that it was the statement made by the gods with reference to their battle with the demons.... (gods say) "we killed the eldest of them all on the Jyēṣṭhā nakṣatra (day) and that is why the star is to be known as 'Jyēṣṭhaghni'.....etc."

The five stars of the constellation of Hṣta present the appearance of the palm of the hand; and it is clear that the group of stars must have received the name Hṣta (hand) from this resemblance.

The Taittirīya Brāhmaṇa has conjured up the vision of nakṣatrya (stellar) Prajāpati which is noteworthy.

यः प्रजापतिं नक्षत्रं विदुः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥
 अथ प्रजापतिः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥
 अथ प्रजापतिः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥ अथ प्रजापतिः ॥

॥ अ. १. ५. २.

"He who knows the nakṣatrya Prajāpati knows him as related to both the worlds. The star Hṣta is his hand, Citra his head, Nisīya (Svātī) his heart, the two Viśākhā stars his thighs, Anurādhā the place to stand upon. This is the nakṣatrya Prajāpati".

Even at the present day the description appears to agree if we look up to the sky and imagine that the figure is formed of a man having raised one hand to one side above his head. Only the star Svātī does not seem to fit in at the place of the heart. The proper motion of this star is far greater than that of others. Therefore, the description must have been true some-time in a very remote past.

The grammatical number in which the nakṣatra names are used is helpful as an indication of the number of stars in each group. The Migasīrṣa group, including the stars representing the head, consists of a good many stars and is called Migasīrṣa. Similarly all the stars of the Hṣta group have together received the appellation Hṣta. Thus, though Migasīrṣa and Hṣta are spoken of in the singular number they are actually composed of a number of stars. As mentioned above the alternative name for Migasīrṣa is 'Invakā' which is in the plural number. The following ten out of the remaining nakṣatras are used in the singular.

Rohiṇi, Ārdrā, Tisya, Citra, Svātī, Jyēṣṭhā, Mūla, Śrōṇā, Satabhiṣak and Revatī.

This shows that each of these nakṣatras must be a single star. Punarvasu, P. Phalguni, U. Phalguni, Viśākhā and Aśvayujā—these five stars are used in the dual number; hence they must have two stars each. The remaining

[illegible]

५. ४. ३. २. १.

that the Śraṣṭhā group consisted of four stars may be seen from

॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥
॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥ श्रीगणेशाय नमः ॥

५. ४. ३. २. १.

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 84

॥ श्रीगणेशाय नमः ॥

॥ श्री. १॥ १०॥

॥ श्रीगणेशाय नमः ॥

•The Saptard group has received the name as the Great Bear in European astronomy.

Even this mantra from the Atharva Samhitā mentions a celestial golden boat; the word 'Pusya' in this appears to have some connection with the star Pusya. A constellation situated close south of Punarvasu and Pusya is called *Navis* (Nau or a boat) in the European astronomy. This appears to be the Nau of the Vedas.

ECLIPSES

Let us now see what other astronomical references can be gleaned from the Vedas. Here is a passage from the Rk Samhitā which mentions an eclipse.

यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥
 यदा सूर्यः स्वर्गोत्तममर्त्यविश्वद्वयः ॥ अथैवावर्त्यमर्त्यं यन्मृत्युर्द्वयः ॥ ५ ॥

“(5) Oh god Sun! When the demon Rāhu (moon's ascending node) engulfed you with darkness, all the worlds so appeared that people living in them were unable to know where they stood.

(6) Oh Indra! You destroy the illusions of 'svarbhānu' (Rāhu) which are found to exist under the sky. The sage Atri got back the Sun who was engulfed by the impious darkness by means of the fourth Brahman.

(7) Oh sage Atri! May that malicious demon desirous of devouring food, not devour me with that dreadful darkness. You are a friend and truth is your riches. May you and god Varuṇa protect me here.

(8) The sage Atri, after selecting the grāva (stone) for extracting some juice for gods and after offering prayers and salutations to them, dispelled the illusions of Rāhu and set his eye on the Sun's light (i.e. remained watching till the Sun became free from darkness)*.

(9) Atri alone could restore the Sun whom the demon Rāhu had engulfed with darkness and no one else could do it.”

There are two or three important points in this description. The first thing to note is that this description of the eclipse does not reflect a highly panic-stricken mood. Solar eclipses are quite frequent, but only a few of them are visible at a particular place; and even out of these few, the total solar eclipse is quite rare. In England, a total solar eclipse was observed on March 20, 1140 A.D. and the next one followed as late as 22nd April, 1715 A.D. which shows that no total solar eclipse was observed during the intervening 575 years. In India, the total solar eclipses do not occur at such long intervals; nevertheless, they are likely to occur once or twice in one's life time. It is clear that Sāyanācārya has translated the third line in a different way and his rendering of the other parts of the passage also is slightly different.

that the 'fads' quoted above describe a total eclipse of the sun, still the description does not betray a high degree of amazement or horror. This shows that in those times eclipses had become quite familiar and the dread of that phenomenon had lost much of its edge. Secondly, what are we to understand from the remark that "the Atris alone could restore the sun and no one else could do it"? This perhaps shows that only the members of the Atri family and no one else had the knowledge of the solar eclipse. And what is meant by no one else had that knowledge? Even a child knows it when an eclipse begins. But even then we are told that Atri alone was able to liberate the sun. This means that Atri alone knew when the eclipse would end and no one else had that knowledge which Atri possessed. This shows that the descendants of the Atri family had at least some knowledge of eclipses, if not, the most accurate knowledge necessary for predicting the exact moment of the beginning and ending of an eclipse just as the ancient Chaldeans knew that the eclipses recur with every cycle of 6586 days or 223 lunar months.

Thirdly, though the wish is once expressed in these Rks that Rahu may not devour the sun, it is said three or four times that Rahu engulfed the sun in darkness, which means that Rahu and darkness are regarded as two different things. A quotation regarding the belief that the moon enters the sun on the new moon day has already been given from the Aitareya Brahmana. It appears from this that even though the true cause of a solar eclipse might not have been known at the time of the eclipse mentioned above, one may safely say that the popular beliefs of those times had a leaning towards the knowledge of the true causes. The notion that Svarbhānu or Rahu devours the sun must have gained ground at a later date.

The *Tāndya Brāhmaṇa* refers to eclipses at five places (4.5.2; 4.6.13; 6.6.8; 14.11.14.15; 23.16.2), in which the 'Svarbhānu' is described as attacking the sun with darkness. In two places (6.6.8; 14.11.14, 15) out of five, the sage Atri is said to have removed the darkness by 'bhāsa' (lustre); in the remaining three places, gods are said to have removed the darkness; but even in those places, the word 'gods' appears to mean the sun's rays. In *Gopāthya Brāhmaṇa* (8.19), the 'svarbhānu' is described as having attacked the sun by means of 'tama' (darkness) and Atri is said to have driven away that 'tama'. According to a description in the *Satapatha Brāhmaṇa* (5.3.2.2.) the 'Svarbhānu' is said to have attacked the sun with 'tama' but Soma and Rudra are said to have removed that darkness.

PLANETS

Let us now see what the Vedas have to say about planets. It need not be told that of the nine planets, the Sun and the Moon together share hundreds of references in the Vedas. Rahu and Ketu are not visible planets at all. Therefore, the remaining five are the only real planets belonging to the solar system. But the author did not come across any reference in the Vedas in which something is explicitly said about all or any of the five planets. There is, however, ample scope for inference.

सर्वे ग्रहाः सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः ॥

सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः ॥

सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः सप्तः ॥

"Oh Asvins ! You have kept one lustrous wheel of your chariot near the sun for adorning him and you revolve round the world by the second wheel." Of these remarks, the first one viz., 'you have kept the lustrous wheel near the sun' very fittingly applies to Venus and the second viz., 'you revolve round the world by the second wheel' applied to Jupiter equally fittingly.

The Nirukta includes Asvins in the list of celestial deities. The time prescribed for offering prayers to them was after midnight. The dawn (Uṣā) was always associated with the Asvins in some way or the other in the hymns addressed to them in the R̥gveda. Habitually rising with the lark, our ancient R̥sis were bound to feel the attraction of the sky.

These facts lend support to our surmise and all things considered, we feel convinced that the "Twin Asvins" were originally none else than the planets Jupiter and Venus.

We come across an independent reference showing that Jupiter was known to be a planet.

सूर्याः सप्त भगवतो यज्ञे यज्ञिभ्यः परं यज्ञम् ॥

सूर्य. ४. ४०. ४. अथ. ४. २०. २. ४.

"Jupiter was first born in the highest heaven of shining light."

This sentence occurs also in Taittirīya Brāhmaṇa (2.8.2). The idea conveyed therein seems to be that Jupiter is a god in the form of a star. The Taittirīya Brāhmaṇa further says :—

सूर्याः सप्त भगवतो यज्ञे यज्ञिभ्यः परं यज्ञम् ॥

सूर्य. ४. ४०. ४. अथ. ४. २०. २. ४.

"Jupiter when born was first visible near the star Tisya (Pusya)".

The maximum latitude of Jupiter is $1^{\circ} 30'$. Hence, there are only 6 out of 27 nakṣatras viz., Pusya, Maghā, Viśākha (Alpha Libra), Anurādhā, Satabhiṣak and Revatī with whom Jupiter can form a close conjunction. Sometimes Jupiter and the star Pusya are so closely conjoined that they together appear to be one body. The idea of Jupiter having been born near Pusya star might have arisen when Jupiter was seen emerging from such occultations. Evidently this would call for the knowledge of Jupiter's motion, that is to say, the knowledge that Jupiter was a 'wandering star' or planet. The presiding deity of Tisya is Bṛhaspati. Even now the conjunction of Jupiter and Pusya is regarded as the most auspicious.

Contd. from previous page

Venus rose heliacally in the east on 26th September and Jupiter rose in the east on 21st November. The two, therefore, began to be seen in the eastern sky before dawn from 21st November. Now they are being seen very near together for the last 2 or 3 days. They will come nearest to each other after about two days, i.e. on 2nd January 1888, that is to say they will be in conjunction. About 1st of June, while Venus will still be seen rising in the east, Jupiter will be seen on the point of setting in the west, and after a few days Venus will disappear in the east. A gentleman who had no knowledge of astronomy, pointed out to me, of his own accord, early in the morning that two planets were situated near each other. It is not, therefore, possible that the attention of our ancient sages was not drawn to Jupiter and Venus in the same way when they conjoined. —The Author

अथः अथः अथः ॥ १० ॥ अथः अथः अथः ॥ १० ॥
 अथः अथः अथः ॥ १० ॥ अथः अथः अथः ॥ १० ॥
 अथः अथः अथः ॥ १० ॥ अथः अथः अथः ॥ १० ॥

अथः अथः अथः ॥ १० ॥

From this it is clear that at the time of the composition of Atharva Veda the term graha has come to be applied to some celestial bodies. The words "May the cāndramasa graha and Aditya graha along with Rāhu prove auspicious to you" seem to refer to the planets eclipsing the sun and moon; and the additional remark "May the planets moving in the sky bring happiness to you" appears to have been made with reference to planets such as Venus.

The German Professor Weber* who is of opinion that the Hindus have borrowed even the nakṣatras from the Babylonians declares that it appears from the names of planets that the Hindus discovered them independently.

On the whole, we feel that the Indian people had the knowledge of the planets Venus and Jupiter in the Vedic age; and if this be true, it is not improbable that they might have had some knowledge also of Mars who sometimes appears as bright as Jupiter, or of Mercury who always remains near the Sun, and of the slow moving planet Saturn.

METEORS AND COMETS

The quotations from Atharva Samhitā (19.9) given above contain the words *Ulka* (Meteors) and *Dhūmaketu* (Comets). Varāhamihira has extensively dealt with the results of a meteor striking against a star.

AUSPICIOUS TIME

Even in the Vedic age people believed that an auspicious time is necessary for doing anything.

अथः अथः अथः ॥ १० ॥

अथः अथः अथः ॥ १० ॥

"Vipra (intelligent) [Varuṇa] established the reciter of hymns in an auspicious day, after expending the passing days and nights".

The Taittirīya Sūti contains good many instructions for performing the *agnyādhan* and other rites on particular nakṣatras and some of them have already been given above in some context or other. Some more are given below:—

अथः अथः अथः ॥ १० ॥

अथः अथः अथः ॥ १० ॥

"On the rise of nakṣatras he breaks his silence saying 'perform a particular rite'."

It is well known that the works on Dharmasāstra abound in instructions regarding certain rites to be performed till the rise of nakṣatras and in beliefs that certain persons become purified at the sight of nakṣatras.

* See Weber's *History of the Indian Literature*, Page 251.

५. ५५. ५. ५.

१५. १४. १३. १२. ११.

५. ४. ३. २. १.

५. ४. ३. २. १.

COMMEMORATION OF THE YEAR

Let us now consider as to when the year used to begin in Vedic times. Nowhere in R̥k Samhitā do we find the names of all the seasons mentioned together; only the words Sarad and Hemanta occur in many places in the sense of year. As for the other Vedas whenever all the seasons are mentioned, the list invariably begins with Spring. In both the branches of Yajurveda, Spring has been specifically mentioned as the 'mouth of the year' (The quotation have already been given before). The months are named according to the Madhu-Madhava series, and Madhu and Madhava are mentioned as the two months of Spring. It is, therefore, proved

beyond doubt that during the Yajurveda Samhitā age and during all the Vedic times later, the year used to commence from the month of Madhu and with Spring. The people then might have been occasionally commencing the year from some other season for civil purposes ; but as a rule the year used to commence from Spring. Now the months were lunar and the seasons depend upon solar year ; and if a particular solar year began with the beginning of a lunar year, there being difference of 1 days in the two units of time, the beginning of Spring will not invariably coincide with the beginning of the lunar year and Spring used to set in invariably in the month of Madhu ; there is no doubt that the system of commencing the year with the month of Madhu was in use in the Yajurveda Samhitā age and even in later periods. Some other astronomical features of the Vedic age will be dealt with in the conclusion of Part I.

ASTRONOMY

It seems that the science of astronomy had assumed a tangible shape in the Vedic period. The *Vājasaneyi Samhitā* contains the following lines :—

समिधा सप्तमसि ॥

अ. सं. ३०. १०.

सप्तमसि सप्तमसि ॥

अ. सं. ३०. २०.

(i) "(Go to) an observer of stars for special knowledge" and

(ii) "a calculator for Yajusa."

The first of these quotations occurs even in Taittiriya Brāhmaṇa (3. 4. 1). The words *ganaka* and *nakṣatra darsa* occur here. The Taittiriya Brāhmaṇa (3. 4. 1) mentions also the names of certain sages who were proficient in these sciences. It is stated at one place that a certain sage named Mātsya got some rite performed on an auspicious nakṣatra and it proved beneficial (1.5.2). The anuvāk which contains the names etc. of the month in a year, the days and nights of the month, and muhūrtas and pratimuhūrtas which has already been quoted above has the following lines at the end :—

सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥
सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥
सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥
सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥ सप्तमसि सप्तमसि ॥

"The Vaidēha Janaka went with 'days and nights'. They told that he who knows them becomes sinless and ascends to heaven. Ahina, the son of Aśvattha learnt the science of Sāvitra. He became a swan and ascended heaven. Śrautarṣa Devabhāga learnt the science of Sāvitra. The Varsneya Sūta became united with Aditya."

This appears to be partly related to Vedānta philosophy ; but the context shows that it has also some bearing on astronomy. On the whole we are led to conclude that astronomy had grown into an independent science in the Vedic period.

In the above discussion all the Vedic quotations have been considered together. That does not mean, however, that they were all composed and

made known to the people at one and the same time. Hence, it follows that it was not that the astronomical facts embodied in those quotations were all known to them at one time. It is obvious that the astronomical knowledge must have gradually developed as time rolled on.

It would not be correct to infer whatever has not been mentioned in the Vedas was not at all known to the people of Vedic times. The *Rk Samhitā*, for instance, refers to eclipse but does not mention all the names of stars. The *Taittirīya Sūtri*, on the other hand, contains references to the nakṣatras by hundreds, but does not refer to eclipses at all. But it would be absurd to presume on this ground that the people then knew nothing of eclipses. Other matters also should receive such judicious consideration.

THE DIVINE DAY

An important sentence may be cited before the close of this chapter.

एवं वा एतद्वर्णनम् ॥ यत्तद्वर्णनम् ॥

त. अ. ३. ६. २२.

“The year is equivalent to a day of the gods.”

Gods dwell on the Meru mountain at the North Pole of the Earth, and in the polar regions the day lasts for six months and the night for six months. Hence, the year is known to be equivalent to a ‘divine day’ in the post-Vedic works on astronomy. Who knows whether this remark emanated from a knowledge of the durations of day and night at the poles or not? Be that as it may, the rationale of the Yuga-measure, as expressed in terms of years in the post-Vedic works, is to a certain extent implicit in this sentence. The next Part will treat this question at a greater length.

"Śikṣā, Kalpa, Vyākaraṇa, Nirukta, Jyotiṣa and Chandas" are regarded as the six parts (Aṅgas) of the Vedas. At present a separate Sūtra (Kalpa) for each Veda is available and it is recited generally by the Vaidic Brahmins belonging to each branch (Śākha); as regards other parts, the Vedas cannot possibly have separate ones. The remaining five parts, which are at present available, are recited by Rīgvedi Brahmins only and not by those belonging to other Vedas. The Vedāṅga Jyotiṣa (astronomy) which we hear was recited by Vaidic Brahmins, consists of 36 verses; but there is another work known as Vedāṅga Jyotiṣa and which is commented upon by Somākara. The commentary by Somākara gives the remark "Yajurvedāṅga Jyotiṣa by Śeṣa" at its end. This portion is not at all different from the one recited by the Rīgvedi Brahmins. There is also another work known as Atharva Jyotiṣa. It cannot be said for certain that the three Vedas had originally different "astronomical works" (Vedāṅga Jyotiṣa); it will, therefore, be convenient to call them by different names for a clear understanding of the same. Let us call the astronomical work recited by Rīgvedi Brahmins as "Rīgveda Jyotiṣa" and that which bears the commentary by Somākara as "Yajurveda Jyotiṣa". The Atharva Jyotiṣa is quite a different one. The first two are similar in many respects; out of 36 verses belonging to Rīg-Jyotiṣa, 30 are found in the Yajurveda Jyotiṣa also, which has 13 different verses. The total number of verses on astronomy and belonging to the two sections together amount to 49. It is also interesting to note, that of the 30 common verses, one verse is similar in meaning but different in words and metre.

No information regarding Somākara's date, etc., is available and in no other work or commentary is his name found. His commentary is found to be of two kinds. One is an extensive commentary in which Somākara mentions his name in the beginning and adds at the end the remark "The Vedāṅga Jyotiṣa by Śeṣa ends." The second kind is an abbreviation of the first one. It does not mention either Somākara's name or the word "compiled by Śeṣa", etc. Those verses which are very easy to understand or those which deal with mathematics, are left aside; there is no harm if one thinks that Somākara did not understand the work at all. Even none of other astronomers appears to have attempted to explain the mathematical side of the Vedāṅga Jyotiṣa; and because it has very little in common with other astronomical works, we seldom find its references in them, and those very few references will be dealt with in subsequent pages. This work is a very ancient one and as such occupies an important place in the history of astronomy. It should, therefore, be fully considered.

In 1879 A.D. Prof. Thibaut published a small booklet on the translation of Yajurveda Jyotiṣa, which shows that he could succeed in explaining 6 verses more than what Somākara could do. In 1881 A.D. the author attempted to translate as many verses of Yajurveda Jyotiṣa as he could understand. Late Krishna Shastri Godbole had attempted to explain the work but

SECTION II

THE VEDĀṅGA PERIOD

CHAPTER I—VEDĀṅGAS

I. ASTRONOMY

he could not explain more number of verses than what Prof. Thibaut could. In 1885 late Janardan Balaji Modak, B. A. published a Marathi translation of Rg-Jyotiṣa and Yajur-Jyotiṣa, from which it can be said that he could explain 2 or 3 verses more. He explained only 28 verses out of 49. The author is at present in a position to explain 36 verses out of 49.

At present only the Rg-Jyotiṣa is recited by Brahmīns. It is not known if Brahmīns in any part of India now recite the Yajurveda Jyotiṣa or ever used to do so in the past. There is an interesting thing about the text of Rg-Jyotiṣa which is widely in recitation among the Vaidic Brahmīns. It is worth noting that a number of verses contains words giving erroneous meaning. The words are incorrect; still it is interesting to see that these are recited throughout India in this form.

It is no wonder that people regard the text with the same veneration as the Vedas, and hence, a suggestion to the reciter to replace the incorrect form by a correct one would become unacceptable. It is obvious that the astronomical work would not have been erroneous originally; and hence, the research as to when and how these errors have crept in, would be found very important in the study of the history of the Vedas and Vedāṅgas. It seems that the original Vedāṅga Jyotiṣa must have disappeared some time in the past, and later on some pandit, not understanding the text, must have introduced the recitation of the text from an illegible or incorrectly written edition available to him. This is not the condition of other works connected with Vedic literature and hence the above can become a subject of research for the historians of Sanskrit literature. The author has written later on his findings about some of the verses. Of the six Vedāṅgas, Pāṇini wrote Vyākaraṇa (grammar); Piṅgala is the author of Chandaśāstra (metre), and so were Lagadhā of Rīgveda Jyotiṣa. In the second verse of this astronomical work is written "I am giving the knowledge of time as described by Lagadhā." This is somewhat like the recitation of two verses (devoted to the salutation of Pāṇini) before commencing the recital of *Aṣṭādhyāyī*. It is just possible that Lagadhā was not the author of the whole work; some one might have recast it later on in accordance with Lagadhā's suggestions. "एतत्" is expressed by the Europeans as 'Lagadh' or 'Lagadh'. This confusion seems to be due to the fact that the letter *g* cannot be properly expressed in roman character, and it is on account of this that Prof. Weber has expressed a doubt that if Lagadh be the same person as Laati, he must have lived in the 5th century A. D. But the Sanskrit texts mention the name as 'Lagadhā' beyond doubt.*

In what follows, the translation of more important verses common to both the Vedāṅga Jyotiṣas is given first. In the beginning, the Rg-Jyotiṣa has been taken up and the text is written exactly in the form in which it is actually recited. If the same verse happens to belong to the Yajurveda, but with a different version given by Somākara and giving a better sense, it is also given later on. These are followed by those verses from the Yajurveda which are not found in Rg-Jyotiṣa. Then useful suggestions and criticism are given

* Dr. Kern has published the *Aryabhatīya*. He has in its introduction given some quotations from the original commentary "*Bhāṭiprakāśikā*" in the Malayalam character. The commentator has, at one place, quoted two verses from Vedāṅga Jyotiṣa as "being written by Lagadhācārya". In this he writes the name as "Lagadh". The mistake might have been committed because of the similarity of D & DH in the Malayalam character. It is worth seeing if the Brahmīns of this province while reciting the Rg-Jyotiṣa pronounce the name as "Lagadh".

For the sake of convenient comparison and contrast, the verse numbers belonging to one of the Vedāṅgas are given in the first column and the corresponding verses belonging to the second Vedāṅga are given in the next column. The first two columns are the analysis of verses belonging to Rīgveda Jyotiṣa. and the last 3 columns are that of verses belonging to Yajurveda Jyotiṣa.

Analysis of Vajur-Jyotiṣa

(I) RIGVEDA JYOTISĀ

ॐ नमो भगवते वासुदेवाय ॥ श्रीकृष्णाय नमः ॥ १ ॥
 After saluting Prajāpati who is the lord of the five-year Yuga (which consists of the day, the season, the byana and the month as its parts) I become

purified and then after saluting the god of time and also the goddess of learning (Sarasvatī) I describe the knowledge of time as propounded by the great sage Lagadha".

It is a bit surprising to note that the names of the 5 years comprising the Pāṇca-Samvatsara-Yuga (five-year-period) are not found in the Vedāṅga Jyotiṣa. But Somāśaka has quoted some verses belonging to Garga to which the author has referred in his note on the 8th verse. Those verses give a description of Pāṇca-Samvatsara-Yuga similar to that given by the Vedāṅga Jyotiṣa and they mention names for the five years. The Bṛhat Saṃhitā by Varāhamihira gives the names of years and their Lords. (See Bṛhat Saṃhitā 8-10); some of these Lords are different from those mentioned by Garga. A line from Taittirīya Brāhmaṇa has already been quoted on page 15 which gives the names of Lords of years; but they are only four and different in certain respects. These are given below:—

| Name of the year | | Lords | |
|------------------|------------|----------|--------|
| 1. Samvatsara | . Agni | Garga | Varaha |
| 2. Parivatsara | . Aditya | Aditya | Agni |
| 3. Idāvatatsara | . Candramā | Vāyu | Aditya |
| 4. Anuvatsara | . Vāyu | Candramā | Aditya |
| 5. Idavatsara | | Mṛtyu | Rudra |

फरुतुः सवत्सरायै तयुगं तद्वत्सरा ॥ वरुणं वरुणं वरुणं वरुणं ॥ ५ ॥
If the words "Dvādaśābhyaṣṭam" and "Samyutāp" from Yajur-Jyotiṣa; be substituted for "Dvādaśārdhābḍap" and "Samjñikam" from Rg-Jyotiṣa; the above verse can be translated sensibly as follows:—

"Reduce the current year number (out of the 5 year cycle) by one. Multiply the result by 12. Add number of months elapsed. Double the sum. Add 2 for every sixty. The resulting sum is called Parva Rāśi".

Example.—Find the Parva-number (i) in the beginning of the second year of the cycle and (ii) at the end of the 7th month of the 3rd year.

Solution.—(i) Current year number minus one = $2 - 1 = 1$. $1 \times 12 \times 2$ gives 24. (ii) Current year number = $1 = 3 - 1 = 2$. $(2 \times 12 + 7) \times 2 + 2 = 64$. This is just like calculating the number of days elapsed from the epoch. This shows that one intercalary month is reckoned after 60 Parvas; i.e., after every 30 lunar months. Some verses from Rīgveda-version suggest this; but verse number 37 from Yajur Jyotiṣa definitely mentions the rule.

वत्सरायै तयुगं तद्वत्सरा ॥ वत्सरायै तयुगं तद्वत्सरा ॥ ५ ॥
युगः—
"When the sun and the moon while moving in the sky, come to Vāsava (Dhanistha, 9-Delphinī) star together, then the Yuga, the Māgha (month), the Tāpas (season), the light half of the month, and the winter solstice, all commence together."

• **यस्येति श्रुतिः पुराणेषु ॥ तस्यैति श्रुतिः पुराणेषु ॥ ६ ॥**
 Note :—The Yajur-version "Candramasau" is correct and not the version

"Candramasau."
 "The sun and the moon turn towards North in the beginning of Dhanisthas and towards South in the middle of Aśleṣa. The sun always does this

respectively in the months of Māgha and Śrāvaṇa."

The time when the ayanas were possible in Māgha and Śrāvaṇa can be calculated ; this point has been explained at length in the end.

यजुर्वेदः सप्त-भूमि-उत्पत्तिः ॥ तस्यैति श्रुतिः पुराणेषु ॥ ७ ॥

"During the sun's northward journey the day increases by one Prastha-measure of water and the night becomes short. During the southward journey, the conditions reverse. The increase (of time) during an ayanas is equal to six muhūrtas."

An increase of one Prastha is equivalent to 4/61 nāḍika. In this connection, verse no. 17 may also be seen. At the end of this topic, it is fully discussed as to where an increase of six muhūrtas is possible.

द्वयं सप्त-भूमि-उत्पत्तिः ॥ तस्यैति श्रुतिः पुराणेषु ॥ ८ ॥
यजुर्वेदः सप्त-भूमि-उत्पत्तिः ॥ तस्यैति श्रुतिः पुराणेषु ॥ ९ ॥

(The Yajur-version should be accepted for rational meaning).

"The Ayanas commence twice on the Pratipada, Sapami, Trayodaśī, Caturthi and Daśamī. They are respectively the commencing tithis of both the ayanas which can occur even in dark half of a month."

The 1st, 7th and 13th of the light half and the 4th and 10th of the dark half are these very 5 tithis occurring again, form the 10 beginning tithis of 10 ayanas occurring in the 5 years; and because the ayanas take place in Māgha and Śrāvaṇa, the tithis alternately belong to the two ayanas and hence to the months of Māgha and Śrāvaṇa.

That the above verse is to be rendered in this very particular way is supported by the quotations of Garga given with reference to this portion of Vedāṅga Jyotiṣa.

• In this verse, the words 'first, seventh, etc.' are used in neuter gender, while the word 'tithi' is used in feminine or sometimes in masculine and not in neuter gender; this no doubt creates a difficulty. The author has, therefore, taken them to be adjectives qualifying the word 'day' (Dinam). They are to be regarded as tithis and not civil days of a civil month, since no such specific mention is made, nor does it agree with the Vedāṅga Jyotiṣa system.

यजुर्वेदः सप्त-भूमि-उत्पत्तिः ॥ तस्यैति श्रुतिः पुराणेषु ॥ १० ॥
यजुर्वेदः सप्त-भूमि-उत्पत्तिः ॥ तस्यैति श्रुतिः पुराणेषु ॥ ११ ॥

"Vasu, Tvaṣṭā, Bhava, Aja, Mitra, Sarpā, the two Aśvinas, Jala, Dhātā and Bhadrāpada, Anurādhā, Aśleṣa, Aśvayujā, Pūrvaṣāḍhā, Uttara Phalgunī and Rohiṇī) with which the ayanas begin ; one Ritu (season) is equivalent to 4½ nakṣatras."

ॐ नमो भगवते वासुदेवाय ॥ त्र्यम्बकं यजामहे सुगन्धिं पुष्टपादम् ॥
 This verse should be read as
 ॐ नमो भगवते वासुदेवाय ॥ त्र्यम्बकं यजामहे सुगन्धिं पुष्टपादम् ॥

which is the Yajurveda version and a correct one. In this verse 27 nakṣatras have been indicated by symbolic letters as follows :—

- | | |
|---------------------------------------|-----------------------------|
| 1. Jau—Aśvayujau for Aśvini | 15. Dhā for Anurādhā |
| 2. Drā for Ārdra | 16. Nāḥ for Śravaṇāḥ |
| 3. Gaḥ—Bhagaḥ for P. Phalguni | 17. Re for Revati |
| 4. Khe for Viśākhā | 18. Mī for Mīṣāṣirā |
| 5. Sve—Viśve (Deva) for U. Aśādhā | 19. Ghā for Maghā |
| 6. Hih—Ahitbuddhnyā for U. Bhādrapadā | 20. Svā for Svātī |
| 7. Ro for Rohiṇi | 21. Paḥ—Āpaḥ for P. Aśādhā |
| 8. Śā for Aśreṣā | 22. Ajāḥ—Aja Eka Pad for P. |
| 9. Cit for Citrā | Bhādrapadā |
| 10. Mū for Mūla | 23. Kṛ for Kṛtikā |
| 11. Śak for Śatabhiṣak | 24. Śyāḥ for Pūṣyāḥ |
| 12. Nyāḥ for Bharaṇyāḥ | 25. Ha for Hastā |
| 13. Śa for Punarvasu | 26. Jye for Jyēṣṭhā |
| 14. Mā—Aryamā for U. Phalguni | 27. Śiḥā for Śrāviṣṭhā |

The list contains the nakṣatras beginning with Aśvini and then every 6th nakṣatra from it. The symbols are either the beginning letters or the ending letters of nakṣatra names or those of controlling deities.

The theory underlying this is as follows :— It appears from the above* verse and from the 25 verses of Yajur Jyotiṣa that 1 yuga contains 124 parvas and hence one nakṣatra division is supposed to be divided into 124 parts. One yuga contains 1860 tithis and the Sun revolves through the nakṣatras 5 times during a mahāyuga (see Yajur Jyo. verses 28 and 31). Hence the Sun moves through $\frac{1860}{5} = 372$ parts during one tithi. The following table gives the part (or degree) of a particular nakṣatra which the Sun occupies at the end of each Parva. From this it can be seen that the Sun will be found on the part number which is the ordinal number of nakṣatra in the list. For example : Aśvini is the first and Ārdra is the second nakṣatra; whenever the sun would come to Aśvini (i.e. at the end of 5th, 30th, 55th, 79th and 104th parva) the sun would be found to occupy the first part or a multiple of 27 plus one part and when it would come to Ārdra it would occupy the second part or multiple of 27 plus 2 parts and so on. In the last column of the table is noted the balance which remains after dividing the number of parts of a nakṣatra by 27. Each nakṣatra occupies that place in the list which is indicated by that number. The scheme or the system cited above can not be rightly understood, as the meanings of all the verses are not clear. It is just possible that originally there might have been verses explaining the system, but those verses are now lost for us.

* A nakṣatra is supposed to consist of 610 Kalās (minutes), as given in verses 18 and 21 of Rk-vedān. This number refers to the Moon's motion.

The Sun's position at the end of each Parva in the 5 years of a Yuga.

Serial
No.
of
Parva
Elapsed
Nakṣatra
Current Nakṣatra
Name
Remainder
(27 parts)

SAMVATSA RA

| | | | | | | | | | | |
|------------|---|---|---|----|----|-----|---------------|---|---|----|
| Magha | . | . | . | 1 | 1 | 11 | Satabhiṣak | . | . | 11 |
| Magha | . | . | . | 2 | 2 | 22 | P. Bhādrapada | . | . | 22 |
| Phālguna | . | . | . | 3 | 3 | 33 | U. Bhādrapada | . | . | 6 |
| Phālguna | . | . | . | 4 | 4 | 44 | Revati | . | . | 17 |
| Chaitra | . | . | . | 5 | 5 | 55 | Aśvayuj | . | . | 1 |
| Chaitra | . | . | . | 6 | 6 | 66 | Bharani | . | . | 12 |
| Vaiśākha | . | . | . | 7 | 7 | 77 | Kṛtikā | . | . | 23 |
| Vaiśākha | . | . | . | 8 | 8 | 88 | Rohini | . | . | 7 |
| Jyēṣṭha | . | . | . | 9 | 9 | 99 | Mṛga | . | . | 18 |
| Jyēṣṭha | . | . | . | 10 | 10 | 110 | Ārdra | . | . | 2 |
| Āṣāḍha | . | . | . | 11 | 11 | 121 | Punarvasu | . | . | 13 |
| Āṣāḍha | . | . | . | 12 | 13 | 8 | Āsrēṣā | . | . | 8 |
| Śrāvaṇa | . | . | . | 13 | 14 | 19 | Magha | . | . | 19 |
| Śrāvaṇa | . | . | . | 14 | 15 | 30 | P. Phalguni | . | . | 3 |
| Bhādrapada | . | . | . | 15 | 16 | 41 | U. Phalguni | . | . | 14 |
| Bhādrapada | . | . | . | 16 | 17 | 52 | Hastā | . | . | 25 |
| Āṣvina | . | . | . | 17 | 18 | 63 | Citra | . | . | 9 |
| Āṣvina | . | . | . | 18 | 19 | 74 | Svāti | . | . | 20 |
| Kārtika | . | . | . | 19 | 20 | 85 | Viśākha | . | . | 4 |
| Kārtika | . | . | . | 20 | 21 | 96 | Anurādhā | . | . | 15 |
| Mārgaśīrṣa | . | . | . | 21 | 22 | 107 | Jyēṣṭha | . | . | 26 |
| Mārgaśīrṣa | . | . | . | 22 | 23 | 118 | Mūla | . | . | 10 |
| Pauṣa | . | . | . | 23 | 25 | 5 | U. Āṣāḍha | . | . | 5 |
| Pauṣa | . | . | . | 24 | 26 | 16 | Śrāvaṇa | . | . | 16 |

PARIVATSA RA

| | | | | | | | | | | |
|----------|---|---|---|----|----|----|---------------|---|---|----|
| Magha | . | . | . | 25 | 27 | 27 | Śrāviṣṭhā | . | . | 27 |
| Magha | . | . | . | 26 | 1 | 38 | Satabhiṣak | . | . | 11 |
| Phālguna | . | . | . | 27 | 2 | 49 | P. Bhādrapada | . | . | 22 |

| Month | Serial
No.
of
Parva | Elapsed
Nakṣatra | Part | Name | Remainder
(27 parts) |
|-------|------------------------------|---------------------|------|------|-------------------------|
|-------|------------------------------|---------------------|------|------|-------------------------|

PARIVATSARA—*contd.*

| | | | | | |
|------------|----|----|-----|---------------|----|
| Phalguṇa | 28 | 3 | 60 | U. Bhādrapada | 6 |
| Caitra | 29 | 4 | 71 | Revati | 17 |
| Caitra | 30 | 5 | 82 | Aśvayuj | 1 |
| Vaiśākha | 31 | 6 | 93 | Bharaṇi | 12 |
| Vaiśākha | 32 | 7 | 104 | Kṛttikā | 23 |
| Jyēṣṭha | 33 | 8 | 115 | Rohiṇi | 7 |
| Jyēṣṭha | 34 | 10 | 2 | Ārdra | 2 |
| Āṣāḍha | 35 | 11 | 13 | Punarvasu | 13 |
| Āṣāḍha | 36 | 12 | 24 | Puṣya | 24 |
| Śrāvṇa | 37 | 13 | 35 | Āśleṣā | 8 |
| Śrāvṇa | 38 | 14 | 46 | Māgha | 19 |
| Bhādrapada | 39 | 15 | 57 | P. Phalguṇi | 3 |
| Bhādrapada | 40 | 16 | 68 | U. Phalguṇi | 14 |
| Āṣvina | 41 | 17 | 79 | Hastā | 25 |
| Āṣvina | 42 | 18 | 90 | Citra | 9 |
| Kārtika | 43 | 19 | 101 | Svati | 20 |
| Kārtika | 44 | 20 | 112 | Viśākha | 4 |
| Mārgaśīṣṭa | 45 | 21 | 123 | Anurādhā | 15 |
| Mārgaśīṣṭa | 46 | 23 | 10 | Mūla | 10 |
| Pauṣa | 47 | 24 | 21 | P. Āṣāḍha | 21 |
| Pauṣa | 48 | 25 | 32 | U. Āṣāḍha | 5 |
| Magha | 49 | 26 | 43 | Śrāvṇa | 16 |
| Magha | 50 | 0 | 54 | Śrāviṣṭhā | 27 |
| Phalguṇa | 51 | 1 | 65 | Śatabhiṣak | 11 |
| Phalguṇa | 52 | 2 | 76 | P. Bhādrapada | 22 |
| Caitra | 53 | 3 | 87 | U. Bhādrapada | 6 |
| Caitra | 54 | 4 | 98 | Revati | 17 |
| Vaiśākha | 55 | 5 | 109 | Aśvayuj | 1 |
| Vaiśākha | 56 | 6 | 120 | Bharaṇi | 12 |

IDYAVATSARA

VEDANGA PERIOD

Serial No. of Parva
Elapsed Nakṣatra
Current Nakṣatra
Name
Part
Remainder (27 parts)

IDYAVATSARA—contd.

| | | | | | | | | | | | |
|----------------|---|---|---|----|----|-----|-------------|---|---|---|----|
| Jyēṣṭha | . | . | . | 57 | 8 | 7 | Rohiṇi | . | . | . | 7 |
| Jyēṣṭha | . | . | . | 58 | 9 | 18 | Mṛga | . | . | . | 18 |
| Āṣāḍha | . | . | . | 59 | 10 | 29 | Ārdra | . | . | . | 2 |
| Āṣāḍha | . | . | . | 60 | 11 | 40 | Punarvasu | . | . | . | 13 |
| Āḍhikā Śrāvāṇa | . | . | . | 61 | 12 | 51 | Puṣya | . | . | . | 24 |
| Āḍhikā Śrāvāṇa | . | . | . | 62 | 13 | 62 | Āśvina | . | . | . | 8 |
| Śrāvāṇa | . | . | . | 63 | 14 | 73 | Magha | . | . | . | 19 |
| Śrāvāṇa | . | . | . | 64 | 15 | 84 | P. Phalguni | . | . | . | 3 |
| Bhādrapada | . | . | . | 65 | 16 | 95 | U. Phalguni | . | . | . | 14 |
| Bhādrapada | . | . | . | 66 | 17 | 106 | Hasia | . | . | . | 25 |
| Āṣvina | . | . | . | 67 | 18 | 117 | Citra | . | . | . | 9 |
| Āṣvina | . | . | . | 68 | 20 | 4 | Viśākhā | . | . | . | 4 |
| Kārtika | . | . | . | 69 | 21 | 15 | Anurādhā | . | . | . | 15 |
| Kārtika | . | . | . | 70 | 22 | 26 | Jyēṣṭha | . | . | . | 26 |
| Mārgaśīrṣa | . | . | . | 71 | 23 | 37 | Mṛga | . | . | . | 10 |
| Mārgaśīrṣa | . | . | . | 72 | 24 | 48 | P. Āṣāḍha | . | . | . | 21 |
| Paṇḍa | . | . | . | 73 | 25 | 59 | U. Āṣāḍha | . | . | . | 5 |
| Paṇḍa | . | . | . | 74 | 26 | 70 | Śrāvāṇa | . | . | . | 16 |

ANUVATSARA

| | | | | | | | | | | | |
|----------|---|---|---|----|----|-----|---------------|---|---|---|----|
| Magha | . | . | . | 75 | 0 | 81 | Śrāviṣṭha | . | . | . | 27 |
| Magha | . | . | . | 76 | 1 | 92 | Śatabhiṣak | . | . | . | 11 |
| Phalguṇa | . | . | . | 77 | 2 | 103 | P. Bhādrapada | . | . | . | 22 |
| Phalguṇa | . | . | . | 78 | 3 | 114 | U. Bhādrapada | . | . | . | 6 |
| Caitra | . | . | . | 79 | 5 | 1 | Āṣvayuj | . | . | . | 1 |
| Caitra | . | . | . | 80 | 6 | 12 | Bharaṇi | . | . | . | 12 |
| Viśākhā | . | . | . | 81 | 7 | 23 | Kṛttikā | . | . | . | 23 |
| Viśākhā | . | . | . | 82 | 8 | 34 | Rohiṇi | . | . | . | 7 |
| Jyēṣṭha | . | . | . | 83 | 9 | 45 | Mṛga | . | . | . | 18 |
| Jyēṣṭha | . | . | . | 84 | 10 | 56 | Ārdra | . | . | . | 2 |
| Āṣāḍha | . | . | . | 85 | 11 | 67 | Punarvasu | . | . | . | 13 |

| Month | Serial No. of Parva | Elapsed Nakṣatra | Part | Name | Current Nakṣatra | Remainder (27 parts) |
|-------|---------------------|------------------|------|------|------------------|----------------------|
|-------|---------------------|------------------|------|------|------------------|----------------------|

ANUVATSARA—*contd.*

| | | | | | | |
|------------|----|----|-----|-------------|---|----|
| Āṣāḍha | 86 | 12 | 78 | Puṣya | . | 24 |
| Śrāvṇa | 87 | 13 | 89 | Āśleṣā | . | 8 |
| Śrāvṇa | 88 | 14 | 100 | Magha | . | 19 |
| Bhādrapada | 89 | 15 | 111 | P. Phalgunī | . | 3 |
| Bhādrapada | 90 | 16 | 122 | U. Phalgunī | . | 14 |
| Āṣvina | 91 | 18 | 9 | Citrā | . | 9 |
| Āṣvina | 92 | 19 | 20 | Svātī | . | 20 |
| Kārtika | 93 | 20 | 31 | Viśākhā | . | 4 |
| Kārtika | 94 | 21 | 42 | Anurādhā | . | 15 |
| Mārgaśīrṣā | 95 | 22 | 53 | Jyēṣṭhā | . | 26 |
| Mārgaśīrṣā | 96 | 23 | 64 | Mūla | . | 10 |
| Paṇṇā | 97 | 24 | 75 | P. Āṣāḍha | . | 21 |
| Paṇṇā | 98 | 25 | 86 | U. Āṣāḍha | . | 5 |

IDVATSARA

| | | | | | | |
|------------|-----|----|-----|---------------|---|----|
| Magha | 99 | 26 | 97 | Śrāvṇa | . | 16 |
| Magha | 100 | 0 | 108 | Śrāviṣṭhā | . | 27 |
| Phalgunā | 101 | 1 | 119 | Śatabhiṣak | . | 11 |
| Phalgunā | 102 | 3 | 6 | U. Bhādrapada | . | 6 |
| Caitra | 103 | 4 | 17 | Revatī | . | 17 |
| Caitra | 104 | 5 | 28 | Āṣvayuj | . | 1 |
| Vaiśākhā | 105 | 6 | 39 | Bharaṇī | . | 12 |
| Vaiśākhā | 106 | 7 | 50 | Kṛttikā | . | 23 |
| Jyēṣṭhā | 107 | 8 | 61 | Rohiṇī | . | 7 |
| Jyēṣṭhā | 108 | 9 | 72 | Mṛga | . | 18 |
| Āṣāḍha | 109 | 10 | 83 | Ārdra | . | 2 |
| Āṣāḍha | 110 | 11 | 94 | Punarvasu | . | 13 |
| Śrāvṇa | 111 | 12 | 105 | Puṣya | . | 24 |
| Śrāvṇa | 112 | 13 | 116 | Āśleṣā | . | 8 |
| Bhādrapada | 113 | 15 | 3 | P. Phalgunī | . | 3 |
| Bhādrapada | 114 | 16 | 14 | U. Phalgunī | . | 14 |

| Serial | No. of Parva | Elapsed Nakṣatra | Part | Name | Remainder (27 parts) |
|--------|--------------|------------------|------|------|----------------------|
|--------|--------------|------------------|------|------|----------------------|

IDVATSARA—contd.

| | | | | | |
|--------------|-----|----|-----|-----------|----|
| Āśvina | 115 | 17 | 25 | Hasta | 25 |
| Āśvina | 116 | 18 | 36 | Citra | 9 |
| Kārtika | 117 | 19 | 47 | Svāti | 20 |
| Kārtika | 118 | 20 | 58 | Viśākha | 4 |
| Mārgaśīrṣa | 119 | 21 | 69 | Anurādhā | 15 |
| Mārgaśīrṣa | 120 | 22 | 80 | Jyēṣṭha | 26 |
| Pauṣa | 121 | 23 | 91 | Mūla | 10 |
| Pauṣa | 122 | 24 | 102 | P. Āśādhā | 21 |
| Adhika Māgha | 123 | 25 | 113 | U. Āśādhā | 5 |
| Adhika Māgha | 124 | 26 | 124 | Śravaṇa | 16 |

कदा दश च विंशत्यै द्विपञ्चनक्षत्रे ॥
द्विपञ्चनक्षत्रे तु पञ्चनक्षत्रे च ॥ ११ ॥

प्रमाण—

कदा दश विंशतः..... ॥ पञ्चनक्षत्रे तदा..... ॥

"10¹/₂ kalās make one 'nāḍikā', two nāḍikās are equal to one 'muhūrtā' and 30 muhūrtas or 603 kalās make one day".

नक्षत्रे द्विपञ्चनक्षत्रे ॥ पञ्चनक्षत्रे च ॥ पञ्चनक्षत्रे तदा..... ॥ १० ॥

The verse does not mention any relation between "Āḍhaka" and "Drona". Similarly the 24th verse of Yajur-Jyotiṣa, which gives different wording, does not give any relation. Varāhamihira, in the Varṣanādhyaṣya, says

पञ्चनक्षत्रे पञ्चनक्षत्रे पञ्चनक्षत्रे ॥ २ ॥

शु. श. २३.

It seems, while writing out this chapter, he must have had before his mind this very verse from Vedāṅga Jyotiṣa. But although he has made use of the term 'drona' in the next verse, he does not mention any relation between 'āḍhaka' and 'drona'. It may be, he did not find any suitable place wherein to mention this relation, because the four 'quarters' of the verse were already composed. Also, the commentator Bhaṭṭopala says, "because 50 palas are said to make one āḍhaka, and four āḍhakas make one drona". These parts of a verse so much agree with the 2nd and 3rd quarters of 17th verse of Vedāṅga Jyotiṣa, that Bhaṭṭopala appears to have taken the quotation, without doubt, from Vedāṅga Jyotiṣa. Bhaṣkaraśāstra and the others have also mentioned 'drona' as equivalent to 4 'āḍhakas' and the real verse of Vedāṅga Jyotiṣa ought to run as follows and it will then remain in agreement with the context :—

नक्षत्रे द्विपञ्चनक्षत्रे ॥ पञ्चनक्षत्रे च ॥ पञ्चनक्षत्रे तदा..... ॥ १० ॥

"One muhūrtā=two nāḍikās; 50 palas=1 āḍhaka; 4 āḍhakas=1 drona—this being larger than one nāḍikā by 3 kudavas".

Here we have to take for granted the words "Tān one nāḍikā". This word occurs in the first quarter and we can take it without much difficulty. The sense which we thus get tallies with the clear meaning of the verse given by the Yajur-Jyotiṣa, which runs thus:

एतां पञ्चाशतिं पालां नदीनां प्रमाणं ॥ २४ ॥

तां पालां पञ्चाशतिं पालां नदीनां प्रमाणं ॥ २४ ॥

"The vessel known as 'ādhaka' holds 50 palas of water. Measure one droṇa of water with it. Throw away from it water equal to 3 kuḍavas in volume. Then the time needed for the remaining water (to trickle away) is known as one nāḍikā".

The measure of the unit Kuṭapa (Kuḍava) which occurs in the verse needs understanding. Similarly another unit 'Prastha' denoting some measure of time has occurred before in verse No. 7. Vedāṅga Jyotiṣa does not give any relation between Prastha and Nāḍikā. Let us try to understand it. Bhāskaraācārya says,

प्रस्थस्य पालाः पञ्चाशतिः प्रमाणं ॥ २४ ॥

प्रस्थस्य पालाः पञ्चाशतिः प्रमाणं ॥ २४ ॥

प्रमाणं ॥

Meaning :—4 kuḍavas=1 prastha

4 prasthas=1 ādhaka

4 ādhakas=1 droṇa

and according to Vedāṅga Jyotiṣa, 50 palas make one ādhaka. Hence, the following units can be interrelated as

1 droṇa=200 palas=64 kuḍavas. 1 prastha=12½ palas.

1 ādhaka=50 palas. 1 kuḍava=3½ palas.

Also according to Vedāṅga Jyotiṣa, 1 nāḍikā=1 droṇa minus 3 kuḍavas. Hence, 1 nāḍikā=61 kuḍavas=(200—3×3½) palas=190½ palas and 1 prastha=12½ palas.

therefore, 1 prastha= $\frac{12\frac{1}{2}}{4}$ = $\frac{190\frac{1}{2}}{61}$ nāḍikās.

It has been said in the 7th verse above that the day-light increases by 1 prastha per day, and it has been now proved that 1 prastha=4/61 nāḍikās, and this agrees with the theory underlying the method of calculating 'measure of day' (Dinamāna) described in 22nd verse. This shows that we have correctly established the relation between prastha, nāḍikā and other units. It has been proved that 'nāḍikā' stands for that measure of time during which 190½ palas volume of water would trickle away; but no rule is given as to how to regulate the size of the hole to ensure the correctness of time for a definite volume of water to flow out. It appears that it was considered unnecessary to dilate upon this as the ghaṭikā vessel had come into common use since a long time. According to Amarakoṣa, Līlāvati and other works, one pala=4 kārṣa=4 tolas of water; or 190½ palas×4=762½ tolas; which amounts to a volume greater than 9 seers of water. The ghaṭikā-vessels which are found in use at present can hold 1½ seers of water at the most. The bigger the vessel in size the greater is the accuracy of time and hence big vessels are always desirable.

The unit of time known as 'pala' appears to have been derived from the time which 1 pala (spoon) full of water takes to trickle out. The pala, therefore, is a unit of volume and of time also. In astronomy the word 'pāṇiyapala' is found in use to indicate a 'pala-unit' (see Siddhānta Śiromaṇi). According to Vedāṅga Jyotiṣa, a ghaṭikā was not considered to be equivalent to 60 palas but equal to 190½ pāṇiyapalas. This measure is inconvenient for calculations. However, the work does mention, 'a day=60 nāḍikās' and it appears that the identity (1 nāḍikā=60 palas) might have come into use; and just as in Vedāṅga Jyotiṣa, the measure of one nāḍikā has been described as the time for 190½ palas of water to trickle out, so the future generations may begin to define a nāḍikā as the time for 60 palas of water to pass out. It does not matter as to the number of palas which a nāḍikā would consist of; since, one nāḍikā has always to remain equivalent to 1/60th part of a day, it is constant in value. The relation '1 nāḍikā=60 palas' can be maintained if the size of aperture in the vessel of capacity 60 palas be so adjusted that the water in it would pass out in exactly 1 nāḍikā time. Even at present, people do not care to know as to how much water their 'ghaṭikā patra' (nāḍikā vessel) should hold. They take care to see that the bore is sufficiently small so that the water oozes out exactly in 1 ghaṭikā time. The measure of a nāḍikā as adopted in Vedāṅga Jyotiṣa period no doubt appears very inconvenient, but it will be shown later on that it is really a convenient one.

सप्तम्युक्त्यां घृतिर्वा नदीवा ॥ यथाति च पदंतिः कालः पचासतः सप्तः ॥ १८ ॥
युःपतः--सप्तमं युक्तं सप्तः घृतिं नदीवा ॥

There will be very little change if the word 'Syona' in the first quarter of the Rk-verse be replaced by 'Syena'.

"The moon remains in a nakṣatra for a period of 1 civil day+7 (kalas). The Sun remains there for 13½ days. 5 letters are equal to 1 kṣāṭhā". A solar year consists of 366 and one Yuga contains (366×5)=1830 civil days (see Yajurveda-verse No. 28); and the moon moves through the nakṣatras 67 times during one Yuga (see Yajurveda-verse No. 31). The moon, therefore, moves through 67×27 nakṣatras in one Yuga. One day consists of 503 kalas. Hence, one Yuga contains 1830×603 kalas. The moon, therefore, requires $1830 \times 603 \div 67 = 16410$ Kala-time (= 1 day 3 kalas) to pass through one nakṣatra. The sun takes 366 days to move through 27 nakṣatras; hence, it requires $366 \div 27 = 13\frac{2}{3}$ days to pass through a nakṣatra.

सिद्धांति गणयन्तस्तस्मिन्मसि तिथिर्वा ॥

घृतिपतनां पचासतः पचासतः सप्तः ॥ १९ ॥

(First half is unintelligible. Translation of second half:—"Multiply the solar month by six, the result will be lunar seasons".

Sun's complete revolution through stars is known as a year and 6 seasons occur in this period, so the six lunar seasons will occur in moon's one revolution through the Zodiac. But the moon's one revolution is equal to one solar month. Hence number of solar months multiplied by six will give the period for the moon's seasons. This is an approximate result. According to Vedāṅga Jyotiṣa the moon makes 67 revolutions in 60 solar months, and therefore, one solar month gives rise to $67 \div 60 = 6\frac{1}{6}$ lunar seasons.

यः पचासमस्य सप्तमं तिथिं ॥

सिद्धांति गणयन्तस्तस्मिन्मसि तिथिर्वा ॥ २१ ॥

"To obtain 'Adana Kala' (i.e. Bhogya or elapsable number of kalas) at the end of the day falling on a parva, add seven times tithi to the Adana Kalas (elapsable kalas) of the nakṣatra (=Bha) on the parva-day in question".

One civil day contains 603 kalas and a nakṣatra is equivalent to 610 kalas. Hence, the moon after passing through 603 kalas in one civil day, still leaves 7 kalas more to be passed over next day; it thus leaves 14 kalas more after 2 days and so on. The above rule is based on this theory. The tithi here stands for a "civil day".

अनुत्पत्त्यनन्तरं च पक्षेऽपि गणनायाम् ॥

नक्षत्रं पक्षेऽपि त्रिंशत् पक्षेऽपि त्रिंशत्पक्षमात्रम् ॥ २२ ॥

पक्षः पक्षः—

अनुत्पत्त्यनन्तरं च पक्षेऽपि गणनायाम् ॥

नक्षत्रं पक्षेऽपि त्रिंशत् पक्षेऽपि त्रिंशत्पक्षमात्रम् ॥

(The work 'Tadevasaṣṭya' in both these versions must be replaced by 'Tadekaṣaṣṭya' to give a sensible meaning).

"Find the number of days elapsed after Uttarāṣṭra or number of days yet to go for the Dakṣiṇāyana; multiply the number by 2 and divide the product by 61. Add 12 to the quotient getting the measure of a day in "muhūrtas". One can understand the theory underlying the above method from the fact that one year consists of 366 days, one ayana contains 183 and the total increase during this period is 6 muhūrtas. Therefore daily increase over 12 muhūrtas would be $\frac{1}{18}$ or $\frac{1}{21}$ muhūrtas or $\frac{1}{21}$ nādikās.

EXAMPLE.—Find the "length of the day" on the day just after Uttarāyana commences. The increase = $\frac{1}{18}$ muhūrtas. Therefore the "dinamāna" or length of the day will be $12\frac{1}{18}$ muhūrtas or $24\frac{1}{3}$ nādikās.

In verse 7 it has been already stated that the day increases by a prastha, and it was proved in 17th verse that a prastha was equal to $\frac{1}{21}$ nādikās. The relation of 61 kuṇḍavas equal to one nādikā is a convenient adoption to avoid lengthy multiplications and divisions.

नक्षत्रं पक्षेऽपि त्रिंशत् पक्षेऽपि त्रिंशत्पक्षमात्रम् ॥ २३ ॥

पक्षः पक्षः—अनुत्पत्त्यनन्तरं च पक्षेऽपि गणनायाम् ॥ २३ ॥

(Yadardham has been taken as the correct word).

"Ritu-śeṣa (balance of a Ritu) is obtained by the sum of balances in all parvas; at the end of each parva a balance of a half-tithi remains".

The time between two parvas is equal to a "half-lunar month". A Yuga contains 1830 civil days, 120 half-solar months and 124 parvas; hence, a half-lunar month = $\frac{1830}{124} = 14\frac{1}{2}$ civil days and a half-solar month = $\frac{1830}{124} = 14\frac{1}{2}$ civil days. The balance per parva is, therefore, $15\frac{1}{2} - 14\frac{1}{2} = 1$ civil days = half-tithi. The seasons depend upon solar months; hence, this is the balance in half-lunar month. This is termed "Adhimāsa śeṣa" in books on astronomy. The balance in 30 lunar months comes to be $1\frac{1}{2} \times 60 = 29\frac{1}{2}$ civil months which is equal to one lunar month. Hence, one month is reckoned as intercalary after every 30 lunar months. The theory about the intercalary month and the meaning of the above verse will thus be clear.

अथः पक्षः पक्षः—अनुत्पत्त्यनन्तरं च पक्षेऽपि गणनायाम् ॥ २४ ॥

नक्षत्रं पक्षेऽपि त्रिंशत् पक्षेऽपि त्रिंशत्पक्षमात्रम् ॥ २४ ॥

अथैतान् देवतान् क्रतुः ॥
 इति क्रतुः ॥ २३ ॥
 अथैतान् देवतान् क्रतुः ॥
 इति क्रतुः ॥ २४ ॥

These verses give the names of controlling deities of 27 nakṣatras. The names of nakṣatras are not given, but the order definitely begins from Kṛtikā. The commencing part of 27th verse reads "Viṣṇu-Varuṇo-Vasavo". From this, deities of Śraviṣṭhā and Śatabhiṣak become respectively Varuṇa and Vasu; but the Taittirīya Śruti and all astronomical works give names in reverse order. The Yajurveda-version of this part is "Viṣṇu-Vasavo-Varuṇo"; this must be the correct reading and should be accepted.

The nakṣatras and their deities are as follows :—

| Serial number | Commencing from | Name | Deity |
|---------------|-----------------|------|-------|
|---------------|-----------------|------|-------|

| | | | |
|----|----|-------------|-------------|
| 8 | 1 | Kṛtikā | • Agni |
| 9 | 2 | Rohiṇi | • Prājāpati |
| 10 | 3 | Mṛgaśīrṣā | • Soma |
| 11 | 4 | Ārdra | • Rudra |
| 12 | 5 | Punarvasu | • Aditi |
| 13 | 6 | Puṣya | • Bṛhaspati |
| 14 | 7 | Āśvīn | • Sarpa |
| 15 | 8 | Māghā | • Pitarā |
| 16 | 9 | P. Phalgunī | • Bhaga |
| 17 | 10 | U. Phalgunī | • Aryama |
| 18 | 11 | Hastā | • Savitā |
| 19 | 12 | Citā | • Tvāṣṭā |
| 20 | 13 | Śvātī | • Vāyu |
| 21 | 14 | Viśākhā | • Indragot |
| 22 | 15 | Anurādhā | • Mitra |
| 23 | 16 | Jyēṣṭhā | • Indra |
| 24 | 17 | Mūla | • Nirṛti |
| 25 | 18 | P. Aśādhā | • Apah |
| 26 | 19 | U. Aśādhā | • Viśvedeva |
| 27 | 20 | Śravaṇa | • Viṣṇu |
| 1 | 21 | Śraviṣṭhā | • Vasu |
| 2 | 22 | Śatabhiṣak | • Varuṇa |

| Serial number
Commencing from
Svigha Kṛtika | Name | Deity |
|---|-----------------|---------------|
| 3 | P. Bhādrapada . | Ajākapāda . |
| 4 | U. Bhādrapada . | Ahīrbudhnya . |
| 5 | Revati . | Puṣa . |
| 6 | Aśvayuj . | Aśvinau . |
| 7 | Bharaṇi . | Yama . |

सम्यक्त्वा एत एतान्मन्त्रान् ॥ यथास्तु शस्त्रेणैव तथैव स्यात् ॥ २८ ॥

"These are the deities of nakṣatras. The holy preceptors (Śastrajñas) ordain that the sacrificer should adopt a name based on the nakṣatra (at birth)."

(Note.—Other astronomical works give a method by which persons are given names according to the nakṣatra-quarter at birth, and the same is still in vogue).

विष्वक् नक्षत्रं शतम् अक्षरैश्च वक्ष्यामि ॥ यथास्तु तानि पर्वण्ये तानि विचक्ष्यामि ॥ ३१ ॥

"[...].....To find the tithis and parvas elapsed when a certain equinox (after the 1st one) would fall,] Subtract 1 from the number of equinoxes under question. Multiply the remainder by 2 and by 1. Multiply each product by 6. The first product gives the number of parvas elapsed and the second product tithis"

EXAMPLE.—To find when the 10th equinox would fall.

Method.—

$$10-1=9 \quad 9 \times 2 \times 6=108 \text{ parvas} \\ 9 \times 1 \times 6=54 \text{ tithis} \\ 108 \text{ parvas}+54 \text{ tithis}=111 \text{ parvas}+9 \text{ tithis.}$$

Adding to this, period elapsed for 1st equinox from the beginning of Yuga, i.e., 6 parvas+3 tithis =117 parvas+12 tithis

The 10th equinox would, therefore, fall after 117 parvas and 12 tithis would pass, i.e., at the end of Kārtika Kṛṣṇa Dvādāśī (12th tithi of dark half of Kārtika) in the 5th year of the Yuga.

The Yajurveda-version for this formula runs thus :—

विष्वक् विचक्ष्यामि अक्षरैश्च वक्ष्यामि ॥ यथास्तु पर्वण्ये तानि विचक्ष्यामि ॥

This verse can directly and easily be rendered as follows :—"Subtract 1 from the equinox-number and multiply the difference by 2. Multiply the result by 6 giving 'pakṣas'. The half of this pakṣa-number would be the tithi at the equinox time."

विष्वक् नक्षत्रं शतम् अक्षरैश्च वक्ष्यामि ॥ यथास्तु पर्वण्ये तानि विचक्ष्यामि ॥ ३२ ॥

यथास्तु—यथास्तु पर्वण्ये तानि विचक्ष्यामि ॥

यथास्तु पर्वण्ये तानि विचक्ष्यामि ॥

Replacing the word 'Pravṛtta' from Rk-version by the word 'Prapaṇa' the Yajur-ṣyotis reading would be translated thus:—

"The knowledge of time concerning the 5 year-cycle (yuga) which commences with the light half of Māgha and ends with the dark half of Pausa is being described now".

यजुर्वेदे यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं

यजुर्वेदोक्तं ॥ ३३ ॥

"The equinox occurs on the 3rd, 9th, 15th, 6th and 12th tithis (and again on these very tithis in the same order)".

It has been shown before, that the equinox day was known in Vedic times.

The first equinox occurred 3 solar months after the winter solstice and the second one 6 solar months after the first. According to Vedāṅga ṣyotis three solar months are equivalent to 93 tithis; and because the Yuga commenced from the first tithi of Māgha, the first equinox must fall on the 3rd tithi of light half of Vaiśākha. After six solar months, that is after 6 lunar months and 6 tithis, the next equinox must occur. Hence, we get the 9th tithi in the formula. All the equinoxes occurring in a Yuga are given together in a table later on.

The term 'Trayodasī' is not clear; otherwise, the verse must be translated as above.

यजुर्वेदे यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं

यजुर्वेदे यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं

The verse is understandable if the 9th letter 'thah' is omitted.

"The sun and the moon come nearer to one another on the 14th tithi (of dark half). The moon is so positioned that when it rises, the day dawns. It conjuncts with the sun on the 1st tithi of light half of Māgha in the day time and also with the Śraviṣṭhā asterism. Similar is its position (at the end of the first parva) before the commencement of rainy season."

The moon rises when the day has begun, that is, just after sunrise. This is possible on the 1st tithi of light half of Māgha (on the junction of New Moon and 1st tithi). The sun and the moon always conjunct on each New Moon day. The object of mentioning only two New-moon days is that it is only on two occasions during a Yuga that the Udagayana or Dakṣiṇāyana commence on New-moon days, the first one being the Utiarāyana on the commencing tithi of Māgha in the beginning of the first year and the second one being the Dakṣiṇāyana in the beginning of Śrāvana in the third year.

(2) YAJURVEDA JYOTIS

यजुर्वेदे यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं

"The later Rtu commences after every alternate day and alternate month from the former Rtu."

Two solar months make a season; and the dates of commencement of these seasons during five years are given in a table later on. It will be seen that the term 'Ekantaṛenhi' (i.e. alternately) applies to tithis.

यजुर्वेदे यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं यजुर्वेदोक्तं

"Multiply the number of parvas elapsed by 11; add to this the product of number of tithis by 9. Divide the sum by 124, and add the parva-number to the quotient, which gives the solar nakṣatra (on the desired tithi)".

Example:—(i) To find the solar nakṣatra at the end of full-moon in the month of Māgha in the 1st year of the cycle. Solution:—
$$\frac{135}{11} \times 9 = 135. \quad \frac{124}{11} = 11 + \frac{12}{11}$$
 Here the quotient is 11 and the parva (Tithis) i.e. $15 \times 9 = 135$. $\frac{124}{11} = 11 + \frac{12}{11}$ The sun has therefore crossed 11 parts of the 2nd number elapsed is zero. The sun has therefore crossed 11 parts of the 2nd nakṣatra.

(ii) To find the solar nakṣatra at the end of 3rd parva. Because three parvas have elapsed, $3 \times 11 \div 124 + 3 = 3\frac{33}{124}$. This shows that the sun has crossed 33 parts of the fourth nakṣatra.

उद्यतं यमस्य सृष्टिमर्तिः स्रवणः । स्रष्टुर्वासेन सृष्टिर्वासेन वसतः सृष्टिः ॥ २६ ॥
 "The sun (Vasava) rises five times the number of days in a year of the yuga (i.e. 1830). The moonrises (R̥si) are 62 less."

One kālā is equivalent to 124 kashāḥ.

“A yuga consists of 61 civil months, 62 lunar months and 67 sidereal months. One civil month consists of 30 days, and the solar month of 30½ days. The sidereal month is the time taken by the moon to make a complete revolution through the zodiac.”

$$11 \text{ 6 11 } 11111 \left(\frac{78}{8} \right) 11111 : 11111 (328) 111111 111111 11111$$

॥ ८ ॥

॥ ३ ॥ ॐ नमो भगवते वासुदेवाय ॥ ॐ नमो भगवते वासुदेवाय ॥

॥ ०४ ॥ पुनः (४४) पुनः पुनः पुनः पुनः पुनः

॥ ११ ॥ ॥ ११ ॥

॥ ८८ ॥ पुनर्जातं पुनर्जातं पुनर्जातं पुनर्जातं

॥ ३३ ॥

वाराणसी विश्वविद्यालय (२०१०) पुस्तकालय विभाग: वाराणसी।

The Composition period

European scholars like Colebrooke have found out the time of Vedānga Jyotisha, basing their calculations on the assumption that in those times sun and the moon conjuncted on the winter solstice day with the beginning point of the Dhanishtha division, the zodiacal divisions being supposed to begin from the Revati star. It amounts to supposing the Alpha-Dehina star as the beginning point of Dhanishtha division, which is not the case, the fact being that the star Alpha is in advance of the beginning point by $4^{\circ} 11'$; and hence, the time calculated by them is mistaken by an amount of time (viz. 300 years) which is necessary for the equinoctial point to recede by $4^{\circ} 11'$. What does the statement "winter solstice began at the beginning of Dhanishtha" mean? How can we say that the winter solstice commenced when the sun and the moon come near that imaginary point which is the beginning of an imaginary Dhanishtha division? And it is a fact that the beginning point of the Dhanishtha division (which is one of the nakshatra divisions belonging to Avinyadi system) is an imaginary point.

* There is some misprint in the reading. It ought to give 1800 as the meaning.

The next important point to remember is that, whatever be the period of composition of Vedaṅga Jyotiṣa, the fact remains that the Aśvinādi system of nakṣatra division had not come into vogue and hence, the beginning point of Dhanishṭha division belonging to this system was also unknown. The mathematicians will, therefore, agree that the time calculated on the assumption of the sun and the moon's coincidence with this beginning point of Dhanishṭha as the moment of Udagayana, was no doubt mistaken.

The verses should clearly be taken to mean that the Uttarāyana commenced when the sun and the moon came near the cluster of 4 or 5 visible stars. At the moment of winter solstice, the tropical longitudes of both the sun and the moon must be 270° or 9 rāśis; and because it took place at the beginning of Dhanishṭha, it is evident that the longitude of Dhanishṭha also used to be 9 rāśis. Keropant regarded Alpha-Delphinī as the junction star of Dhanishṭha; Colebrooke also regards the same. The author has calculated the tropical longitude of this star in 1887 A.D. as being 10° 15' 48" 29' i.e., in excess over 270° by 45° 48'. Taking 50" as annual precessional motion of equinoxes, the time for this excess comes to be 3297 years. Subtracting this figure from 1887, we get 1410 B.C. as the year when the longitude of Dhanishṭha could be 9 signs i.e., when the winter solstice used to take place near the Dhanishṭha stars. This comes to be the time of Vedaṅga Jyotiṣa. If we regard Beta-Delphinī as the junction-star as supposed by Prof. Whitney, the time would prove to be 72 years earlier, and since all the stars in this asterism lie within a degree, the time of the 'Jyotiṣa work' will not much vary. On an average 1400 B.C. should be regarded as the time. Colebrooke and others calculate the time as follows:—

The equinox used to occur near the Zeta-Piscium star near about the year 572 A.D. In those days the winter solstice used to take place at the end of the first quarter of the Uttarāṣāḍhā nakṣatra division instead of in the beginning of Dhanishṭha, as described by Vedaṅga Jyotiṣa. A shifting of 1½ nakṣatras i.e., 23° 20' had then taken place. The time for this shift at the rate of 50" per year comes to be 1680 years. Hence, the winter solstice used to occur near the beginning of Dhanishṭha about the year (1680-572) or 1108 B.C. The figure is shorter by 300 years because of the supposition that Udagayana used to take place "in the beginning of the Dhanishṭha division". It has already been pointed out above that the time should be calculated on the basis that winter solstice took place near a star of Delphinī group.*

The time of composition of Vedaṅga Jyotiṣa as astronomically calculated by the author is quite correct beyond doubt; but some European scholars on philological grounds, believe it to be "not so old". They attempt to bring the times of our ancient works as late as possible. Max Müller writes that it was composed in the 3rd century B.C. Prof. Weber even suspects it to have been written in the 5th century A.D. Let us, therefore, examine this point more critically.

*The precessional motion is gradually increasing at a very slow rate. It might have been a bit smaller than 50" in 1400 B.C. Taking 48" as the motion, the above calculated time would come to be smaller by about 135 years. The time calculated by Colebrooke and others differs from the one viz. 1108 B.C. etc. calculated by me because of the assumption of different precessional motions and of different years for the conjunction of equinoctial point with the Zeta-Piscium star.

Varāhamihira says:—

अथार्द्धिगुणसूत्रम् तद्विज्ञेयम् ॥ तत्र कालिदासीयसूत्रम् पूर्वोक्तम् ॥ १ ॥
 निम्नम् तत्रैवः कर्कशम् गुणितम् ॥ अथार्द्धिगुणः
 अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥ अथार्द्धिगुणः
 अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥ अथार्द्धिगुणः
 अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥ अथार्द्धिगुणः

After describing the astronomical positions of the sun at the commencement of Ayanas (Solstices) in the times of Vedāṅga Jyotiṣa, he remarks "as told in ancient Śāstras". The whole trend of the description shows that in his time (near about Śaka year 427) the Vedāṅga Jyotiṣa had come to be regarded as "very old". He has, in his Pīṭamahā Siddhānta (which was a part of Pañca Siddhāntikā) given some mathematical formulae, which had been out of use in his time as being very old; and the author has shown in 'Part Two', that the formulae resembled with those given by Vedāṅga Jyotiṣa.

Brahmagupta says,

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

This shows that at the time of Brahmagupta and Varāhamihira the Pīṭamahā Siddhānta was being regarded as having been written very many years ago. A good many quotations from Garga have been given before; it appears that Vedāṅga Jyotiṣa occupied an important place in his time. Even Parāśara says:—

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

This gives the same solar position for winter solstice as given by Vedāṅga Jyotiṣa. This shows that it must have been composed long before these two seers lived. Although the Sāmhitās composed by Garga and Parāśara do describe the Vedāṅga Jyotiṣa, the circumstances for a winter solstice to occur at the commencement of Dhanīsthā had no doubt altered. While commenting on the portion 'Aprāptamākara' in Chapter 3, Bih. Samp., Bhāṣṭopala has quoted the following verse:—

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

अथार्द्धिगुणः तत्रैवः कर्कशम् गुणितम् ॥

Parāśara's verse also has been quoted above. These verses show that Vedāṅga Jyotiṣa was composed long before the times of Garga and Parāśara; but it is very difficult to fix up their times. Garga has been a very famous astrologer in India (See Gadāparva, Chap. 8, verses 14 and 15). The name of Garga has occurred a number of times in Pāṇini (See 4-3-110, across the names of Parāśara and Garga even in Pāṇini) (See 4-3-110, 4-10-105, etc.). The two, therefore, must have lived before Pāṇini and Vedāṅga Jyotiṣa was composed long before them. According to Dr. Bhandarkar,

Pāṇini's time comes to be the beginning of 7th century B.C. and according to late V. Kunte it was the beginning of 9th century B.C. The words "Samvatsara, Parivatsara etc." occur in Pāṇini (See 5-1-92) and the measures of Āḍhaka and Khāṛi etc., as described by Vedāṅga Jyotiṣa were in use in Pāṇini's time (See 5-1-53). These support the view that Vedāṅga Jyotiṣa existed long before Pāṇini. Another important consideration leads one to believe that it was composed in those times when the Vedic methods of performing sacrifices were well known and perfectly set up in society, as can be seen from the fact that Vedāṅga Jyotiṣa has specially described the method of calculating the "Viśuvān" day correctly, this day being regarded as the most important one by Āitareya and Taittirīya Brāhmaṇa. Now, although some philological evidences like the words "*Yaiha Sikkha Mayurāṇam*" might appear to be modern, it can not be said so about all other verses. Dr. Martin Haug says (in his lecture on the Vedas) "the word 'Gharma' has been used by Vedāṅga Jyotiṣa to mean a 'day'. (See verse 7 Rk-reading). The use of the word in this sense had become out of use long before Yaska who lived before Pāṇini.

The Vedāṅga Jyotiṣa must, therefore, have been written near about the times of composition of 'Śrauta and Smārta sūtras' i. e. between 1200 and 600 B. C. There are no evidences of the nature of astronomical terms, that Vedāṅga Jyotiṣa belonged to an earlier period. It used a terminology different from the one in which number are indicated by words, e.g. the number 'four' is denoted by the word Veda. Prof. Weber says that the names of nakṣatras given by Vedāṅga Jyotiṣa are like those found in modern books and that it contains Rāśi-names also. The author has already translated the verse in which the term Rāśi occurs. He maintains that not only Vedāṅga Jyotiṣa does not give Rāśi-names, but also it does not give nakṣatra-names which are current in modern times. Of the list of nakṣatras, the Rk-version clearly gives the name of only one star, and that too as Śraviṣṭhā and not as Dhanīṣṭhā of the modern times. The verse No. 36 of Yajurveda version gives names of 9 stars, and the list gives Āsvayuk as the ancient name and not as Āsvini for one of them, while others are modern names. Similarly, verse No. 14 of Rk-version gives a list of symbolic names of stars which can help one in differentiating ancient names from modern ones, e.g. Āsvayuk and Satabhīṣak which are ancient names. It no doubt contains a name, Śravaṇa, which appears to be modern, yet it is not similar to the name "Śroṇā" of the Taittirīya Brāhmaṇa. The star used to be called as Śravaṇa even in the times of Atharva Saṃhitā (See pp. 47-48) and of Pāṇini (see Pāṇini, 4. 2. 5; 4. 2. 23). Prof. Weber's arguments do not, therefore, deserve consideration. All the above considerations will support the author's view that we must accept that time for the composition of Vedāṅga Jyotiṣa which one gets on grounds of astronomical calculation.

The Place of Composition.

Let us attempt to find out the place of its composition on the basis of statements about length of the day as given by Vedāṅga Jyotiṣa. The verse No. 7 & 22 (Rk-version) say that the daily increase in the length of day is 61 nāḍis and that the lengths on solstitial days are 24 and 36 ghaṭis respectively. The "Dinārdha" i. e. length of half-day comes to be respectively 12 and 18 ghaṭis, and the correction for ascensional difference is 3 ghaṭis. The sun acquires maximum declination on the two occasions. The value of Sun's maximum declination about the year 1400 B.C. used to be 23° 53'. Our

astronomical works give it to be 24°. Let us try to find by the following method the stations where both the values can be true:—
Formula:— $\sin(A.D.) \times \cot(\text{declin}) = \tan(\text{lat. of place})$. Here, A.D. = 3 ghaṭis = 18°.

$$(i) \quad L \sin 18^\circ = 9.489982 \quad (ii) \quad L \sin 18^\circ = 9.489982$$

$$L \cot 24^\circ = 10.351417 \quad L \cot 23^\circ 53' = 10.353801$$

$$\therefore L \tan(\text{lat.}) = 9.841399 \quad \therefore L \tan(\text{lat.}) = 9.843783$$

$$\therefore \text{latitude} = 34^\circ 45' 8'' \quad \therefore \text{latitude} = 34^\circ 54'$$

This shows that the place of composition must be a place whose latitude is either $34^\circ 46'$ or $34^\circ 55'$. The work gives $4/61$ nādi as the daily increase in length. The fact is that the increase is never constant. It is minimum when the sun goes to solstices and is maximum when it comes to equinoxes. At a place on latitude 35° , the increase in length of day would be found to be only $1/61$ ghaṭi (at the most) in two days near about solstitial days and about $5\frac{1}{2}/61$ ghaṭis per day on or about equinoctial days.

Ayana Calana (Shifting of Equinoxes)

The Vedāṅga Jyotiṣa mentions the commencement of a Yuga as coincident with that of the winter solstice and also that of Dhanuṣṭha. It is clear from this that they had no idea of shifting of equinoxes in those times.

Detailed information about length of a year etc. in the Vedāṅga Jyotiṣa Period

| Number in a Yuga | No. of days in a year | Dates of equinoxes | Dates of commencement of seasons | Omitted (Kāya) Tithis |
|--------------------------|-----------------------|---|---|---|
| (1) Solar months 60 | Samvatsara 355 | (i) Vaiśākha S. 3
(ii) Kārtika S. 9 | Magha S. 1
Chaitra S. 3
Jyēṣṭha S. 5
Śrāvaṇa S. 7
Āṣvina S. 9
Mārgaśīrṣa S. 11 | Chaitra S. 2
Jyēṣṭha S. 4
Śrāvaṇa S. 6
Āṣvina S. 8
Mārgaśīrṣa S. 10 |
| (2) Lunar months 62 | | | | |
| (3) Intercalary months 2 | Parivatsara 354 | (i) Vaiśākha S. 15
(ii) Kārtika S. 6 | Magha S. 13
Chaitra S. 15
Jyēṣṭha S. 2
Śrāvaṇa S. 4
Āṣvina S. 6
Mārgaśīrṣa S. 8 | Magha S. 12
Chaitra S. 14
Jyēṣṭha S. 1
Śrāvaṇa S. 3
Āṣvina S. 5
Mārgaśīrṣa S. 7 |
| (4) Civil days 1830 | | | | |
| (5) Tithis 1860 | | | | |
| (6) Kāya tithis 30 | | (i) Vaiśākha S. 12
(ii) Kārtika S. 3 | Magha S. 10
Chaitra S. 12
Jyēṣṭha S. 14
Śrāvaṇa S. 1
Āṣvina S. 3
Mārgaśīrṣa S. 5 | Magha S. 9
Chaitra S. 11
Jyēṣṭha S. 13
Śrāvaṇa S. 30
Āṣvina S. 2
Mārgaśīrṣa S. 4 |
| (7) Sideral months 67 | Idavatsara 384 | | | |
| (8) Nakṣatras 1809 | | | | |
| (9) Viddhi nakṣatras 21 | | | | |

| Total | 1830 | 10 | 30 | 30 |
|-------|-------------------|---|--|---|
| | Anuvatsara
354 | (i) Vaisākha S. 9
(ii) Kārtika S. 15 | Magha S. 7
Caitra S. 9
Jyēṣṭha S. 11
Śrāvāṇa S. 13
Āśvina S. 15
Mārgaśīṛṣa K. 2 | Magha K. 3
Caitra K. 5
Jyēṣṭha K. 7
Śrāvāṇa K. 9
Āśvina K. 11
Mārgaśīṛṣa K. 13
Adhika K. 30 |
| | Idvatsara
383 | (i) Vaisākha K. 6
(ii) Kārtika K. 12 | Magha K. 4
Caitra K. 6
Jyēṣṭha K. 8
Śrāvāṇa K. 10
Āśvina K. 12
Mārgaśīṛṣa K. 14 | |

The dates on which the ayanas in a Yuga begin are already given on p. 71. The dates of commencement of seasons are given in the above table. It should be noted that (i) between each pair of these dates, one more solar month falls. These two lists together would give 60 dates of month-beginnings. (ii) The first intercalary month is inserted between Āśāḍha and Śrāvāṇa of the 3rd year (after 30 lunar months have elapsed after Yugaḍi), and the second is inserted after 30 more lunar months elapse, that is, after Pausa of the 5th year. Thus Śrāvāṇa and Māgha always happen to be intercalary months in each Yuga. (iii) Because one yuga consists of 1830 civil days and 1860 tithis, the number of 'Lapsed tithis' comes out to be 30. (iv) Similarly, because the moon revolves 67 times during the period, the number of nakṣatras through which it passes would be $67 \times 27 = 1809$ and hence, in 1830 civil days the increase in their number becomes 21. The nakṣatra cycle begins from Śravisṭhā (See verses 25 to 27, Rk-version). Under Vedāṅga Jyotiṣa system the moon and the sun are supposed to move by a uniform motion, which is termed as "mean motion" in astronomical works; and because a mean tithi is shorter than a mean civil day, a tithi-vyddhi can never occur; so also a "lapsed nakṣatra" can never occur because the mean length of a nakṣatra is greater than a civil day.

The Paścātya

The above discussion will make it clear that once a 5-yearly calendar is compiled, it would serve the purpose for all yugas to come. The detailed paścātya can not be given here for its being very extensive; its salient features are, of course, described above.

Let us now examine the correctness of the lengths of the year and of other units of time.

| | Vedāṅga
Jyotiṣa | Sūrya
Siddhānta | Modern European |
|-------------------------------------|--------------------|--------------------|---|
| Number of civil days
in a yuga. | 1830 | 1826.2938 | 1826.2819 (Sidereal) |
| No. of days in
62 lunar months | 1830 | 1830.8961 | 1830.8964 |
| No. of civil days
in 95 years | 34770 | 34699.58 | 34699.36 (Sidereal Yr.)
34698.03* (Tropical Yr.) |
| No. of days in
1178 lunar months | 34770 | 34787.03 | 34787.03 |

This shows that while the error in the measure of a lunar month is very small, that in the solar year is big**. The result is that if the first 'ayana' would take place on a Māgha Sukla 1 of a certain Yuga, it will not take place on the same tithi of the next yuga but 4 days earlier; similarly, after 95 years it will take place some 72 days earlier and so on. The error in the measure of a lunar month is very small; yet, because the cumulative error would amount to 54 ghatas in 5 years, there will be an error of about one day in 5 years, even if we reckon full moons and new moons according to the Vedāṅga Jyotiṣa system. But, although the error in the case of ayanas is not easily detectable, that in the case of Pūrṇimā and Amāvāsya can be readily found. From this, it seems that they must have taken 1830 as the round figure for the number of civil days in a yuga, while reckoned by actual observations of the positions of the moon on full-moon days, it must have been coming to about 1831 days; and because the number of lunar months in 95 years (including 38 intercalary months) being taken to be 1178, the number of civil days in 19 yugas or 95 years would actually come to be 34787 or (according to Vedāṅga Jyotiṣa) 34770, and the next Māgha Sukla 1 would again be so after 95 years and would be the first tithi of the 96th year. But the fact remains that 95 solar years would consist of 34698 days, which shows that the winter solstice (coming in the 96th year) would fall 89 days (or at least 72 days) earlier than the Māgha S. 1. of that year, which amounts to a difference of $2\frac{1}{2}$ to 3 lunar months. To avoid this the number of intercalary months should not be taken as 38 (as per Vedāṅga Jyotiṣa system), but only 35; otherwise a difference of 3 seasons would occur in 200 years. This is too much to be neglected.

*This is calculated from the length of a solar year in 1400 B. C.

**Shri Vraji Raghunath Lele observes that the measure of the length of the solar year is gradually and slowly decreasing and the European scholars also maintain the same view. It is, therefore, probable that Vedāṅga Jyotiṣa was composed in a period in the previous cycle of equinoxes i. e. 28000 years ago, when the length of a year might have been actually 366 days.

Such a wrong system could not have remained in vogue all over the country for a long time; and we can not but believe that the Vedāṅga Jyotiṣa system was not in practice for a very long time. The intercalary months, decayed tithis and excess nakṣatras recur in the same order and these things have much religious importance. The intercalary month is regarded as 'Censurable' even in the Vedas. If, therefore, the Vedāṅga Jyotiṣa system had been in use in all provinces and for a long time we would have come across their references in 'Sūtra' works. This shows that it must have remained in use, if at all, in only some provinces. The rate of increase in the length of day (as given by Vedāṅga Jyotiṣa) is applicable only to a place on latitude 34° N. But this does not in any manner stand in the way of our supposing 1400 B.C. as the probable date of that work. The Taittirīya Srauti gives 4 names for the years, sometimes 5 or even 6. The reason for this, the author believes, must be that the '5-year-cycle' system of Vedāṅga Jyotiṣa did not come into vogue fully then. It was perhaps found that the 'ayanas' repeat with respect to lunar months in a cycle of 5 years, and this must have led them to adopt either 4 years or 6 years for the cycle. It may be that there might not have been any fixed cycle in use and then the author of Vedāṅga Jyotiṣa might have calculated 366 days as the average length of a year and introduced a fixed system of a 5-year-cycle. It is even probable that people must have either discarded the system as wrong or allowed it to continue, adjusting the insertion of intercalary months in their proper place, viz. 35 in place of 38 during a period of 95 years. Almost all our religious rites are performed on the proper lunar positions since time immemorial, and they have found it convenient to adjust the calculation to a correct solar time by adjusting the insertion of intercalary months. The author has already observed in Section I that in his opinion, this was the system in vogue even in the Vedic times. It requires 1000 years to pass for changing the position of winter solstice with respect to a nakṣatra; and they could have controlled the occurrence of winter solstice in Dhanuṣṭhā in the beginning of Maghā and retention of 5 names for the 5 years, by careful adjustment of intercalary months in their proper place, and could have continued the system for some centuries. In short, it can be said that, even if the Vedāṅga Jyotiṣa system would have been out of use in its original form, it must have continued in some other form and that is why we get references about it in astronomical works by Garga and others. It will be shown in a discussion in Part Two, that the Jovian sixty-year cycle owed its origin to this '5 year-cycle' system. That this system has got a place in the list of Vedāṅgas (parts of the Vedas) is itself something very important. It can not be said for certain as to when it obtained that elevated position, but the author believes that it must have received that importance within 200 years of its origin, i.e. before the time when it was found useless in its original form for religious purposes. Varāhamihira does not call it a 'Vedāṅga', but it was definitely so at his time. Brahmagupta (Saka 550) at one place says:—

यथाऽपि पञ्चमः संहितायां यः ॥

अथान्यथाऽपि संहितायां यः ॥ २ ॥

॥ २ ॥

The word 'Aṅga' occurring in this appears to be used to denote Vedāṅga Jyotiṣa. At present it is regarded a part of the Vedas (Vedāṅga).

Aparāṅga (Deformed Readings)

It can not be said for certain as to when the incorrectness entered in the readings of Rg-Jyotiṣa; but the quotation of Varāha viz. "Pañcāśatpala-

maḍhakam" and that of Bhaṭṭopala viz. "Caturbhirāḍhakaironah" show that these did not enter till Saka 427 and 888 respectively. Bhaṭṭopala has taken latter half of verse No. 32 (Rk-reading) in his commentary on the penultimate verse of chapter 8 of Bṛhat Saṃhitā. The author finds the same in a manuscript copy of the book in his possession. It runs thus,

येन पञ्चमं यजुर्वेदं गच्छति ॥

Here the word 'Pañcamasya' seems to be a misprint. It ought to be "Pañcavarṣasya". Similarly, the Vaidikas read "Pracakṣate" in place of "Nibodhata". Hence, if 'Nibodhata' be the original reading by Bhaṭṭopala, it can be said for certain that the incorrectness did not enter into the readings till Saka 888; still, this conjecture can not be said to be a final word on it for want of further evidences.

Pradhāna Pāṭha (The Principal Readings)

The 24th verse of Yajur-Jyotiṣa is similar in meaning to, but different in words from, the 17th verse of Rk-version and quoted by Varāhamihira and Bhaṭṭopala.

This shows that the Vaidic Brahmins in the times of Varāhamihira and Bhaṭṭopala used to recite the Rk-reading (and not the Yajur one) in its correct form; it can be said that the people at least paid greater importance to the Rigveda-reading. The commentator of Aryabhaṭīya, named Sūryadevayajvan has taken two verses* from Vedāṅga Jyotiṣa in his commentary. These happen to be the last two verses, viz. 35th & 36th of the Rigveda-version and are given in this very order, and not in the order of Yajurveda-version—there they stand respectively 4th and 3rd—and looking to the context of the commentary it seems that the taking of first or last verses at that place was quite reasonable. This shows that even at the time of Sūrya Deva, the Rk-reading was considered as more important. The time of Sūryadevayajvan is not known, but he appears to have lived later than Bhaṭṭopala.

In the latter half of 35th verse (See Sūryadeva's commentary) is found the word "Tāṭha" in place of "Tadavat". The word 'Tāṭha' is not found in any of the two Vedic-Jyotiṣa works. If, therefore, the word is Sūryadeva's replacement, it seems that the current Vaidic reading did not come in use in final form at least in his province.

It cannot be said for certain, if the Yajurveda reading was at all known to Varāhamihira, Bhaṭṭopala and Sūryadevayajvan; but the Yajur-reading also appears to be an ancient one; because only six verses from Rk-version are not found in it, and of these six only three important ones viz. 13th, 19th, 33rd are missing. It contains 13 verses more than Rg-Jyotiṣa. These can definitely be seen to belong to the period when Vedāṅga-Jyotiṣa was in vogue and might have been composed by Lagadha himself. Also, the list of cruel and horrifying nakṣatras given in the 36th verse of Yajur-Jyotiṣa does not tally with that given by other astronomical works.

This shows that the Yajur-Jyotiṣa belonged to a comparatively later period. But the 24th verse is quite different in words and the 21st is partially different from similar verses in Rg-Jyotiṣa, and those of the verses (from both the works) which are illegible, some may be similar and others might be opposite in meaning. This leads one to believe that some verses not composed by Lagadha were later on interpolated in the Yajur-Jyotiṣa. The sequence of verses in

*See "Introduction to Aryabhaṭīya" by Dr. Kern.

both the readings is not logical; if an attempt be made to re-write them in the logical order of topics, the order of verses will change much; and this shows that the present order of verses is a result of an attempt at composition by a later writer and in so doing, some of the original verses must have been lost for ever. For instance, the units of *Kāṣṭhā* and *Akṣara* have been mentioned in the same verse, although they bear no relation to other units and they are not seen to have been used anywhere in the text; but the words could not have come in without any reason. These support the author's belief that some original verses must have been lost.

Planetary motions.

Vedaṅga Jyotiṣa has given the motions of the Sun and the Moon only. It mentions nothing about other planets. Although some verses are found illegible, the author can say for certain that they do not give any other important information.

Mean motions of planets

The motions of the Sun and the Moon as given by *Vedaṅga Jyotiṣa* are mean motions, but since these motions change every moment, the sun's true place differs from the mean place by about 2 degrees* and that of the moon by about 8 degrees. It cannot be said for certain if they in *Vedaṅga Jyotiṣa*'s time knew how to calculate the difference between true and mean place of a planet, the term now being known to us as "Equation of centre". *Brahmagupta*, however, remarks in his couplet given on page 93 that astronomers of these times did not have any knowledge of planets' true places.

One will not be able to detect the difference between the true and mean motions and positions of the sun and the moon unless one observes their places and motions regularly and studies them. This difference would come to one's notice at the time of eclipses if one knew that eclipses take place near the ending moments of Full Moon or New Moon. It is nevertheless a matter of pride to us that they in *Vedaṅga Jyotiṣa*'s time had at least the knowledge of sun's and moon's motions, if not of their true places. The daily mean motion and the time for their complete revolution can not be found unless one actually records and calculates the time that the sun and the moon take in a finite number of revolutions, and it is clear that people had obtained this much knowledge before the compilation of *Vedaṅga Jyotiṣa*. The measure of a solar year appears to have been mistaken because of the fact that the *nakṣatras* near about the sun are never visible.

The adoption of mean motions (to the sun and the moon) by *Vedaṅga Jyotiṣa* brought the solstices and equinoxes at the distance of 183 days from one another and the distance of one solstice from the next equinox comes to be 91½ days. But their actual relative distances before the year 1400 B.C. used to be as given below:—

| Distance | Days | Ghatīs |
|--|------|--------|
| From Winter Solstice to Vernal Equinox | 91 | 5 |
| Vernal Equinox to Summer Solstice | 94 | 5 |
| Summer Solstice to Autumnal Equinox | 91 | 30 |
| Autumnal Equinox to Winter Solstice | 88 | 35 |

365 15

* One degree being 360th part of a full circular measure.

The words 'Varṣa' and 'Samvatsara' are found used in Rg-Jyotiṣa to denote a year. The Yajur-Jyotiṣa gives an additional word Abda for it (See 28th verse). The words 'Varṣa' and 'Abda' occur only in Śatapatha Brāhmaṇa of the Vedic literature.

The Month

The months ended with New Moon in this system.

The First Nakṣatra

The first nakṣatra according to Vedāṅga Jyotiṣa is Dhanīṣṭha. The list of controlling deities of nakṣatras as given in Rk verses 25, 26 and 27 begins, as in the Vedas from Kṛtikāś. One comes across a reference of the Dhanīṣṭhādī system in the Mahābhārata. The sixty-year cycle and 12-year Jovian cycle begin from Dhanīṣṭhas.

Arithmetic

People in Vedāṅga Jyotiṣa time knew four fundamental rules and the rule of three. Not only this, but one can say from verses 7, 14, 16, 17, 18 and 22 of Rk-reading and 37th verse of Yajur-reading that they had knowledge of these rules about fractions also. Also the use of shortcuts like Apavartā (simplification) etc. shows that they had taken much pains over the mastery of arithmetic.

The Ascendant (Lagna)

The line 'Sraviṣṭhābhyāṃ' etc. in verse 19 of Rk-reading suggests that they had the idea of Lagna i.e. ascendant. The astronomical works define Lagna as the point of the ecliptic in contact with the horizon. The above verse should be regarded as very important if it means to say something like the definition.

Mesa and other signs

It does not mention any Rāśis (signs) nor was then the system of stating a planet's place with respect to 12 divisions of the ecliptic. The positions of the sun and the moon are given with respect to nakṣatras.

Solar Months

Although no mention of Mesa and other signs is made, the solar months are stated. The word Sūryamaśa actually occurs, and the relation between the solar and lunar months is given in clear terms at good many places. A season is mentioned to consist of 2 solar months or of 4½ solar-nakṣatras and the lunar months with the tithis on which the seasons commence are also specifically mentioned. Again, it contains a method somewhat similar to the one of calculating 'Adhimāsaśeṣa' with respect to the solar and lunar months and described by Śūrya-Siddhānta and similar other works (See verse 23, Rk-version). No solar month had any independent (special) names. These were perhaps named as Caitra, Vaiśākha, etc., as we find with regard to solar months in Bengal.

Parvāṇa (i.e. number of lunations)

This work describes a method of calculating the 'parvāṇa' or number of parvas or lunations elapsed from the commencement of Yuga, much on the lines of calculating 'Aharāṇa' as described by Śūrya-Siddhānta and others.

Identical divisions for time and space

Discussion of this topic will be completed after recording a more important thing. It is the identical division system for both time and space, which came into existence from the time Vedāṅga Jyotiṣa was compiled. In astro-nomical works like *Sūrya-Siddhānta* we find exact similarity in the divisions and subdivisions of time and space as described below :—

| | | | |
|-------------|-------------|------------|---------------|
| 60 Palas | = 1 Ghatikā | 60 Vikalās | = 1 Kalā |
| 60 Ghatikās | = 1 Day | 60 Kalās | = 1 Aṃśa |
| 30 Days | = 1 Month | 30 Aṃśas | = 1 Rāśi |
| 12 Months | = 1 Year | 12 Rāśis | = 1 Perimeter |
| 360 Days | | 360 Aṃśas | of a circle |

Under Vedāṅga Jyotiṣa system the time division and space divisions are identical. The nakṣatra is supposed to be divided into 610 Kalās; and a day is supposed to be divided into 603 parts, because the moon passes over so many parts (i.e. 603 Kalās) of a nakṣatra in 1 day. This subdivision of a day into 603 parts might be found inconvenient for calculation, but this subdivision is convenient when nakṣatras are concerned. The time division is seen to have been suggested by space division. Similarly, the division of 1 yuga into 124 parvas had suggested the division of one nakṣatra into 124 parts or 'Aṃśa'. This is an example of a time division suggesting a space division. Now looking to the fact that the above system was actually in vogue in Vedāṅga Jyotiṣa period and that from Vedic times the relations "1 year=360 days, 1 solar year=12 months, 1 month=30 days and 1 day=60 nāḍikās" have remained in general use, can we not say that these were sufficient enough easily to suggest an Aryan mind that a circular space be divided into 12 parts and each part into 30 subdivisions and that the current space-subdivisions are a result of independent thinking on the part of the Aryans?

(3) ATHARVA JYOTIṢA

The time units

Let us now turn to the study of Atharva Jyotiṣa. This consists of 14 chapters and 162 verses. This has been told to Kaśyapa by Pitāmaha. The author explains its topics briefly.

The time units are given as follows :—

| | | | |
|-----------|-----------|-------------|--------------|
| 12 Nimesa | = 1 Lava | 30 Truṣis | = 1 Muhūrta |
| 30 Lavas | = 1 Kalā | 30 Muhūrtas | = 1 Ahorātra |
| 30 Kalās | = 1 Truṣi | | (whole day) |

These are followed by a list of names of 15 Muhūrtas whose measure is compared with the length of a gnomon 12 'aṅgulas' long. The Muhūrtas are :—

| Muhūrta | Shadow length (in aṅgulas) | Muhūrta | Shadow length (in aṅgulas) |
|--------------|----------------------------|--------------|----------------------------|
| 1. Raudra | 96 (max.) | 5. Savitra | 5 |
| 2. Sveta | 60 | 6. Vairāja | 4 |
| 3. Maitra | 12 | 7. Viśvavasu | 3 |
| 4. Sarabhaya | 6 | 8. Abhijit | |

Abhijit has been described as that Muhūrta in which the shadow does not alter in length or direction. The lengths of shadows of Muhūrtas coming after noon increase in the reverse order. It cannot be said that the shadow at noon is of zero length, but it must be shorter than 3 angulas. The place where this Jyotiṣa was compiled can be found out from this condition; but because the lengths of shadows are not the same throughout the year and it is not an important problem worthwhile attempting, the author leaves out of consideration the problem of finding the place.

The Karapas and Auspicious times

As we proceed further on we come across instructions about the duties to be performed on particular muhūrtas e.g. horridful acts to be done on Kau-dra (Tertifying) Muhūrta, and friendly acts to be done on Maitra Muhūrta. The fourth chapter gives a list of Karapas (or Tithis) with their names which are like those of our present time. Of the stationary Karapas "Kimpusthna" is substituted by "Kauṣtubha". It may be a writer's error. Further on, we find a classification of Karapas responsible for auspicious and inauspicious acts and the ghatikā has been adopted as a time-unit for them. Further on are given, as at present, names of deities controlling the Karapas. They include the Dhanādhipa of Kauṣtubha and Manibhadra of Vajra. The names of remaining deities are those from the Vedas. Next we find a discussion as to which acts, when done on particular tithis, would give auspicious or inauspicious results. This list of tithis includes 5 names like Nanda and Bhadrā—

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥

This verse gives only four "Aṅgas" (i.e. parts) viz. Tithi, Nakṣatra, Karapa and Muhūrta, and not the Yogas.

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥ ६० ॥

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥ ६१ ॥

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥

These verses discuss the auspicious or inauspicious nature of planets depending of course, on the "strength" of the moon; and the words "Na Kṣapakeśaśatīṣa prabhavah" suggest the moon's strength varies with the number of its "Kāṣas".

Vara or names of days and names of planets

The following verse gives names of seven days in a week calling the planets as 'Lords of days':

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥ ६३ ॥

Other verses give following more names of planets as being applicable to names of days:—Surya, Lohitāṅga, Somaśata, Devaguru, Gura, Bhṛgu, Sukra, Sūryasuta.

Jātaka branch of Astrology

After passing over 100 verses, one comes across the quotation

शुक्रः शक्रः शक्रः शक्रः शक्रः ॥

which is followed by 62 more verses. This portion contains the seeds of predictional section of astrology Jātaka and is, therefore, an important one. Some of the verses are given below :

The nakṣatras are divided into 9 groups:—

अथ सप्तविंशतयः सप्तः सप्तमयः ॥ १०३ ॥ सप्तो विष्णुर्देव प्रमो सप्त एव ॥
 सप्तो अमरमयः सप्तमयः ॥ एतौ विष्णोर्देव सप्तमयः ॥ १०४ ॥
 विष्णोर्देव सप्तमयः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०५ ॥
 सप्तमयः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०६ ॥
 सप्तमयः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०७ ॥
 सप्तमयः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०८ ॥

Order of groups Nakṣatra numbers

| | | | |
|-----|------------|--------------------|------------------------|
| (1) | 1 Nakṣatra | 10 Nak. for action | 19 Nak. for foundation |
| (2) | 2 | 11 | 20 Sampatkara Nak. |
| (3) | 3 | 12 | 21 Vipatkara Nak. |
| (4) | 4 | 13 | 22 Kṣemya Nak. |
| (5) | 5 | 14 | 23 Pratvara Nak. |
| (6) | 6 | 15 | 24 Sādhaka Nak. |
| (7) | 7 | 16 | 25 Naidhana Nak. |
| (8) | 8 | 17 | 26 Maitra Nak. |
| (9) | 9 | 18 | 27 Paramamaitra Nak. |

Each group consists of 3 nakṣatras separated by 9. These are to be reckoned from the nakṣatra at birth ; this is clear from verse No. 104. The next verses ordain to do or not to do certain acts on these nakṣatras and by the next verse viz.,

युक्तीनां विष्णोः सप्तमयः सप्तमयः ॥ १०३ ॥ सप्तमयः सप्तमयः ॥ १०४ ॥

The author describes the fears and horrors which befall when certain nakṣatras are accompanied by planets, electric charges, meteors etc. It is evident that by the word 'graha' the planets Sun, Moon and others are meant. Further on something is stated about conception and the discussion is closed by the verses:—

अथ यो विष्णोः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०३ ॥

॥ १०४ ॥

य एव सप्तमयः सप्तमयः सप्तमयः ॥ सप्तमयः सप्तमयः ॥ १०५ ॥

॥ १०६ ॥

No mention is made that the work is to be called Atharva Jyotiṣa; still that it is so is borne by the evidence of the last verse ending with the remark "Amṛtavidhānaṁ".

It is clear from its topics that this Jyotiṣa is not so ancient as the R̥k or Yajur-Jyotiṣas, still the old consideration of the fact that if the Megadī r̥k̥as would have been in vogue in the time of the author of this work, they would certainly have occurred in the text, leads one to accept that the Atharva oṭiṣa is pretty old and because it is so called, the author took it for discussion at this place.

One more important point, worth remembering, is that while no mention is made of 12 r̥k̥as, the names of days (Vāra) do occur; this point will be considered later on.

This work describes a system of astrology, very akin to, and not quite different from, the one which is based on 12 r̥k̥as and is in use in our country; and no doubt can be entertained about the fact that this system of astrology originated and had been independently developed in our country. It seems probable that although the Hindus are said to have borrowed the 12 r̥k̥as from foreigners, they developed the R̥k̥si-Jyotiṣa on the already known lines of astrology related to nakṣatras.

2. KALPA SŪTRAS

Aśvalāyana Sūtra

Names of nakṣatra months are found in Aśvalāyana Sūtra. "*Srāvanyāṃ Paur̥ṇamāsyāṃ Srāvāṇakarma*" is an example (See Gṛhya Sūtra 2-1-1). The names of months like Madhu, Mādhava, etc. are also found (Srauta Sūtra 4-12). At one place, a reference about seasons in the same quotation shows that Spring was regarded as the first season. Although the word tithi does not occur explicitly, the quotations (i) "*Margaśīrṣyāṃ Pratyavarohāṇāṃ Caturdaśyāṃ*" (Gf. S. 2-3-1) (ii) "*Hemantaśīrṣyāyoścaturdamaparakṣa-ndamaśāṃśvāṣṭakāḥ*" (Gf. S. 2-4-1) (iii) "*Adhyāyopākaraṇāṃ Srāvāṇasya Pañcamyāṃ*" (3-5) etc. show that the words Caturdaśī, Aṣṭamī, Pañcamī stand for tithis. References about Ayaṇa and Viṣuva occur at good many places. The references about nakṣatras show that some are used in dual form as, "*Uttarayoh Prosthapadayoḥ*" (Gf. S. 2-1) and in masculine gender plural number also as in "*Uttarayoh prosthapadaiḥ*" (Gf. S. 2-10-3). In Taittirīya Brāhmaṇas, both these star-names are used in masculine and plural number. The names of Pole star (Dhruva), the Great Bear (Saptarṣi) and Arundhatī occur in Gf. S. 1-7-22 as "*Dhruvam arundhatīm Saptarṣinī dṛṣṭva vācam viśjeta*". Definite instruction for doing certain rites on certain auspicious nakṣatras seems to be given in it; e.g. Fields should be ploughed on the Uttara Prosthapada, Phalgunī and Rohiṇī nakṣatras, sacrifices should begin on such and such nakṣatras (Gf. S. 2-10-3); the thread ceremony should be performed on auspicious nakṣatras; the Sīmantonayanaṃ to be performed on 'masculine' nakṣatras conjoined with moon (Gf. S. 1-4-1, 1-14) etc. Which nakṣatras were regarded as auspicious and masculine, is not known. The current works on astrology give a list of masculine and feminine nakṣatras; and the kinds of nakṣatras are similar to those shown on page 48-50. People might be following the same kind of grouping in Sūtra period.

Pāraskara Sūtra

Pāraskara Sūtra seems to belong to a period later than the Aśvalāyana Sūtra. It contains almost all topics discussed by Aśvalāyana Sūtra; but it ordains the "Agrahayāṇi-karma" to be performed on the full moon day of

Other Sūtras

3. NIRUKTA

अथ ये हिंसाभाषित्य विद्याभ्यासं च सधेयवर्त्तेषु ये भवन्ति ते कर्माणि कर्त्तव्यानि ॥ ८ ॥ अथ ये हिंसाभ्यासं च सधेयवर्त्तेषु ये भवन्ति ते कर्माणि कर्त्तव्यानि ॥ ८ ॥ अथ ये हिंसाभ्यासं च सधेयवर्त्तेषु ये भवन्ति ते कर्माणि कर्त्तव्यानि ॥ ८ ॥

V8

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अथवा १४. ॥

अथवा १५. ॥

अथवा १६. ॥

अथवा १७. ॥

अथवा १८. ॥

अथवा १९. ॥

अथवा २०. ॥

अथवा २१. ॥

अथवा २२. ॥

अथवा २३. ॥

अथवा २४. ॥

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अथवा ५९. ॥

अथवा ६०. ॥

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अथवा ९६. ॥

अथवा ९७. ॥

अथवा ९८. ॥

अथवा ९९. ॥

अथवा १००. ॥

Yuga and Other Units of Time

The description about these time units is mostly similar to that found in Manusmṛiti and astronomical works. The Nirukta defines Brahma's one day as the period of 1000 yugas, no clue being given as to the measure of a yuga in years; during this time the creation, maintenance and destruction of the Universe take place. Brahma's night also is of the same length (i.e. 1000 yugas) during which time he sleeps; the period of 'a day plus a night' is called Brahma's "ahorātra". These repeat continuously infinite number of times. The period of Brahma's 'ahorātra' is identical with the one known as 'Kaipa' to the Śūrya Siddhānta and other astronomical works. The word 'Kaipa' does not occur in it. It is needless to say that Nirukta is the most ancient of all works which describe the long period of Yuga and other units. Although nothing is said about the measure of a yuga in terms of solar years, it is certain that it was definitely not so small a measure as five years. However the statements on the whole suggest some larger length for this term.

4. PÄNINI'S GRAMMAR

One comes across words like 'Varga' (5-1-88, 7-3-16) and 'Haryana' (4-1-27; 5-1-130), occasionally found in the Vedas. One can read about lunar months denoted by Caitra etc. (4-1-21) and the term 'Muhūrta' (indicating a part of a day) (3-3-9). Similarly the term 'Nādi' denoting a number one or more than one (and not denoting a sine wave in the body) occurs in it (5-4-159). This shows that the term 'Nādi' was used to indicate some measure of time. The term 'tithi' is not found in Pāṇini; but one should not say from this that the term was unknown to people in Pāṇini's time. This grammatical work does not deal with astronomical subjects or religious topics such as the commands to do or not to do certain acts on certain nakṣatras. Hence, we can not say that the astronomical terms which do not occur in this work were unknown in his time. Also, of the names of yugas (Kṛta etc.), the term Kālī does occur in Pāṇini, but not in the sense of a yuga; this is not sufficient to prove that the Kṛta and other units of yuga were unknown in Pāṇini's time.

The Yuga-System

The System of Vedāṅga Jyotiṣa

अमृतं ब्रह्मरं ज्ञानं अपि नै कुरुममनाः ॥ पण्डितुना स्मृतं ज्ञानं एव स ब्रह्मरं इव ॥२॥

Bhīṣma, while calculating the time elapsed after the Pāṇḍavas went into exile, says to Duryodhana on the occasion of Uttara Gograhana as follows—

॥ श्रीगणेशाय नमः ॥

॥ ३ ॥ पंचमं पंचमं चतुर्थं त्रैलोक्यं त्रैलोक्यं ॥ ३ ॥

[illegible]

॥१॥ ॐ नमो भगवते वासुदेवाय ॥

५२. अ. ५२.

Here we get the reference to the Vedāṅga Jyotiṣa system of inserting two intercalary months in five years.

intercalary months in five years.

Under the Vedāṅga Jyotiṣa system, the nakṣatra-cycle begins from Dhanīṣṭha, which means that Dhanīṣṭha must be considered to be at the origin while stating a planetary position. The Kṛttikās were once regarded as the first nakṣatra before Dhanīṣṭha. An interesting story about the Dhanīṣṭha system is related in the Mahābhārata as follows :—

॥ ॐ नमो भगवते वासुदेवाय ॥

[illegible]

॥ श्रीगणेशाय नमः ॥

॥१॥

॥ श्रीगणेशाय नमः ॥

॥०३॥ मन्त्राणां प्रथमः सूक्तः प्रथमः

11: 11:11 11:11 11:11 11:11

Winter Solstice And Starvina Star

Similarly, the following lines are also worth reading:—

॥ श्री गुरुभ्यो नमः ॥ श्रीगणेशाय नमः ॥ ॐ नमो भगवते वासुदेवाय ॥ १ ॥

• 22 •

Although it is not stated in clear words that winter solstice used to take place in the beginning of Śravaṇa nakṣatra, there is no other reason for calling the nakṣatras as Śravaṇādini commencing from Śravaṇa. Like the Vedāṅga Jyotiṣa system, herein also the nakṣatras are 'Sukādī', that is commencing with light half or ending in New Moons. From this it can, therefore, be inferred that the Vedāṅga Jyotiṣa system continued for few centuries more but in a slight different form. It has already been shown before that the time when winter solstice used to occur near the beginning of Dhanishṭha was about 1400 B. C.; it began to take place in the beginning of Śravaṇa at about 450 B. C.

*Newcomb's Popular Astronomy has given in a map a list of stars which will become polar stars in different ages.

Other Matters

References about seasons, ayanas, Mādhu and other months, and tithis are found at several places. The seasons commenced with 'Sisira', so say the lines. The words "Seasons commencing with spring" also occur at many places. If the year began with W. S., the commencing season must either be Sisira or Hemanta. The following lines support the view that "Caitra and Vaiśākha constitute the Spring season" was the popularly known relation in those times.

वीर्यं मासं वसन्तं शिवन्ते ॥ स्त्रीमस्त्यगुलं मासं ॥१॥

उद्योगपर्व, अ. ८३.

तेषां गुणतया तानिः पर्वतयो एव शारदी ॥ तत्रैव वसन्तमासीदुत्थितयो अयं अय ॥१६॥

वायुपर्व, अ. १८२.

We meet with two lists of names of months in Chap. 106 and 109 of Anuśāsana Parva, in both of which the first month is stated to be Mārgaśīrṣa. Even when the verse concerning Śravaṇa nakṣatra states new moon ending month-system, we come across a statement showing that full moon ending month-system was also in vogue. e.g. see verse No. 96.

शुक्लपक्षेऽश्विनी पक्षे शरदौ चोत्तराः ॥६६॥

वायुपर्व, अ. ८४.

The following verses contain references about parts and sub-parts of a day. The line from verse No. 21, Chapter 7 from Śānti parva viz.,

शारदी कालो मृगशीरष दिवा त्रिकल्पया शरतः ॥२१॥

शान्तिपर्व, अ. ७.

quotes the time-units viz. Kālā, Kāśīhā, Muhūrta and Lava. Similarly the

सप्तमशीतम्, ऋतुम्, मासान्, पञ्चाशत् क्षणान्, क्षणान्, ॥१४॥

From verse 14, Chap. 36 of Sāntiparva gives 'Kṣaṇa' as another unit; but their mutual relationship is nowhere to be found. The term 'muhūrta' occurs at hundreds of places e.g.

स शरतं गुणयितुं मृगशीरषं अयं च ॥१७॥ श्रीवेद्याय, अ. १११.

उद्योगपर्व, अ. ६.

quotes the Jaya muhūrta. The Atharva Jyotiṣa gives Vijaya as the name of the 11th muhūrta. The following verse contains the names of Abhiṣit, of the 8th muhūrta, and the term Tithi (but in masculine form).

युं वैषाखायुजं मृगशीरषितेजसं ॥ तयो मय्याते युं तयो युं तयो ॥१६॥

वायुपर्व, अ. १२३.

The 8th muhūrta, Abhiṣit, is famous in the Atharva Jyotiṣa and other astronomical works. The units, ghaṭi and pala are not to be found anywhere in the Mahābhārata; but the author is not certain about this, since he did not read the work with particular attention to these units.

Week-days

No reference is to be found about 7 days in a week in the Mahābhārata but the author came across a solitary instance in which the word 'Vāra' occurs in the verse No. 7, Chap. 160, Adiparva. The Paṇḍavas used to live with a certain Brahmin in the Eka Cakra Nagari, before Draupadi's 'Svayamvara' was held. In that city there lived a demon and it was agreed between him and the citizens that they should send one man every day for his meals. One day, it was the turn of that Brahmin to send a man to the demon. It is in this connection that the verse is written.

एतं कश्चित् पुरातनकृतं श्लोकः ॥ स वारी शुक्रिचतुर्विधवृत्तः ॥७॥

भाष्य, अ. १६०.

The word 'Vāra' has been used to denote the turn (of a day). It has already been pointed out that the word 'Vāsara' occurs in the Rīgveda. It shows that the term 'Vāsara' or 'Vāra' used to be applied to a day to show a 'turn', before the names of seven days of a week came into vogue.

Nakṣatras

A complete list of 27 nakṣatras is found given at two places (see Chap. 64 and 89, Anuśāsana Parva) but the list begins with Kṛtikās; names of nakṣatras are found at several places. It is not necessary to quote all the concerning verses here; but the author gives below only those few sentences which are worth noting.

The references about Migaśiras comes at some places in stories about god Rudra chasing the Miga (the star-deer) e.g. (See verse 20, Chap. 278, Vana Parva).

अन्धमस्य, यत् रतां वृक्षमस्मिन् यत् ॥२०॥

शतपथ, अ. २७८.

The story of Rudra chasing the deer (Migaśiras) is found in many Sanskrit works and in Saupṭik Parva and also in Chap. 283 on 'Mokṣadharmas', in Śānti Parva. For this, read

मत्तं वृक्षमस्मिन् वारं व सप्तमस्य ॥ यत् वृक्षमस्मिन् तस्मिन् वृक्षमस्मिन् ॥१॥

मत्तः स यत् तस्मिन् वारं वृक्षमस्मिन् ॥ अन्धमस्य यत् यत् यत् ॥२॥

स यत् तस्मिन् वारं वृक्षमस्मिन् ॥ अन्धमस्य यत् यत् यत् ॥३॥

शतपथ, अ. १८.

In the following verses are to be found references about the Punarvasu stars in which the beauty of the twin stars on both sides of the moon is described.

अन्धमस्य यत् यत् यत् ॥ अन्धमस्य यत् यत् यत् ॥२॥

शतपथ, अ. २६.

A reference to star Hasta composed of 5 stars occurs in

अन्धमस्य यत् यत् यत् ॥ अन्धमस्य यत् यत् यत् ॥३॥

शतपथ, अ. २३.

١٤٠٠

[illegible]

A reference to dog star Sirius has already come along with Migea. The names of stars other than 27 standard ones are also found in the Mahabhārata e.g. in the following lines one gets a reference to Agastya (Canopus) and Sap-tarshi with Arundhat (Great Bear).

tarsi with Arundhati (Great Bear).

॥३४॥ अथ भक्त्युत्पत्तिः ॥

००१. ३०. १९५५

॥१२८॥ एतत् पुनश्च पुनः पुनः : पुनश्च पुनश्च

१११. अ. १११

॥१२॥ ५३५६ ५३ : ५३५६ ५३५ ५३५६५३५६

உர்த். ல். உய்யுத

Nowhere in the Mahābhārata is found a single reference to Yoga, Karana, or Rāsi. Had Rāsis been in vogue at any stage of the Mahābhārata's compilation, they would certainly have come in the text. This definitely shows that the terms Aries (Meṣa), Taurus (Vṛṣabha) etc. were not current in the age when the Mahābhārata was compiled. In the same way it was not the system to mention a planet's position with reference to a part after dividing the ecliptic into 12 parts. Everywhere in the Mahābhārata we find the position of the moon and other planets with reference to stars.

The sun's position in the ecliptic does not appear to have been given anywhere in the Mahābhārata, still it can be said that like Vedānga Jyotiṣa, the solar months were known to the Mahābhārata also; not only that, we also get references of 8 'samkrāntis' in the following verse in which their importance as being very auspicious for charity are stated.

पञ्चमं विद्यायां वारणसीं वाराणसीं ॥ १२४ ॥ अथ विद्यायां वाराणसीं वाराणसीं ॥

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००६. ३०. ३००

The terms 'two ayanas' occurring in it are known in astronomical works as Makara and Karka Samkrantis, and the 'Visuvas' are termed Mēsa ard Tula Samkrantis.

Tula Sankranti.

* Some books on astronomy describe *Valkuth* as a cluster of 4 stars. Of these, the star *Alpha* and *Beta* *Libra* are very huminous ; but even these stars fade when the full moon comes in between them. If however, the moon happens to come in between these stars any day prior to the 5th tithi of light half or after the 10th tithi of dark half, the scene is very a scintating. (See P. 37, second edition, *Jyotivilasa*.)

The term 'Sāḍasī' in the *Sūrya-Siddhānta* applies for the four signs, Gemini, Virgo, Sagittarius and Pisces. This term is used in the plural and therefore, the author feels that it signifies the above mentioned four signs. This consideration leads one to infer that so far as stating the sun's position was considered, the ecliptic was divided into 12 portions at the time of the *Mahā-bhārata*.

Eclipses

Ordinary references of solar and lunar eclipses are found at many places. We find the description of fruitfulness of performing *Srāddha* ceremonies, at the times of eclipses (particularly at the time of solar eclipses) and of giving away of lands and other articles in charity. Similarly, we get references of occasions when eclipses took place. For instance, a solar eclipse occurred when the Pāṇḍavas started for exile.

ॐ नमो भगवते वासुदेवाय ॥ ११ ॥

सप्तमः अ. १६

When the sage Vyāsa met King Dhṛtarāṣṭra (before the commencement of the battle) with a view to giving him proper advice, he is said to have uttered the following words.

सप्तमः अ. १६ ॥ ११ ॥ ॐ नमो भगवते वासुदेवाय ॥

सप्तमः अ. २

सप्तमः अ. २ ॥ ११ ॥ ॐ नमो भगवते वासुदेवाय ॥

सप्तमः अ. ३ ॥ ११ ॥ ॐ नमो भगवते वासुदेवाय ॥

सप्तमः अ. ३

These lines and the previous context show that a lunar eclipse had taken place on the Kārtika-full moon and a solar eclipse had fallen on the next new-moon day. The falling of two eclipses in the same month is a common experience; but those two are rarely seen at the same one place; and that is why this is regarded as an ominous incident. This phenomenon is considered at length by Bhāṭṭapala (in Saka 888) in his commentary on *Bṛhat Saṃhitā* (see Chapter on 'Rāhucāra').

Viśvaśhasya Pakṣa

The above lines contain a reference of a 'Pakṣa' consisting of 13 days having occurred at the time of the Bhārata battle. The occurrence of a 'half-month' consisting of 13 civil days is a rarity; and hence it is regarded as an ominous incident. This is called a *Kṣaya Pakṣa* or a missing half. If calculations are done with the formulae given by the *Sūrya Siddhānta* and other astronomical works and if true positions of the sun and the moon are taken into account, we do sometimes get a 13-day half-month; but we can never get it by either adopting the mean motions given by the *Vedāṅga Jyotiṣa* or even by the mean motions given by modern astronomy; because the measure of

*The literal meaning of the word is 'wing' or 'side'. A lunar month is said to have sides or halves viz. the light half and the dark half. This word should not be translated as a "fortnight".

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a half-month according to Vedaṅga Jyotiṣa comes to be 14d. 45gh. 29 $\frac{1}{2}$ p. and that according to S. S. and European astronomical works it comes to 14d. 45gh. 55 $\frac{50}{3}$ p. The 13-day half-month is possible when its mean value would be less than 14 days. This is never possible if mean values are taken for the motions of the sun and the moon; but it is possible if true positions are reckoned. For example, the dark half of Phālguna, Śaka 1793 and the light half of Jyāṣṭha, Śaka 1800 were 13-day half-months. On both these occasions the *Grahaṅgahava almanac* and the *Keropant's almanac* (which took figures from *English Nautical Almanac*) gave a half-month a measure which was less than 14 days by a few ghatis. The occasions when the half-month's measure would be less than 14 days are very few and it is not necessary that a 13-day half-month would emerge on all these occasions. For example, suppose that on the first day of a month (Mesa) or on the 1st date of an English Calendar month the new moon or full moon takes place at 4 ghatis after sunrise and suppose that by reckoning the true motion, the actual measure of half-month came to be 13 days 55 gh.; then the next lunation will take place (i.e. the full moon or the new moon would take place) at the end of 59th ghāṭi on the 14th day. Now, because first Parva-end occurred on the 1st day of the solar or civil month, after sunrise, that civil day would be included in the previous half-month and hence, only 13 days would be left to be reckoned in the next half-month. Taking the same example, if we suppose that the first lunation occurred after 10 ghatis after sunrise on the 1st date, the second lunation will occur on the 15th day at 5 ghatis after sunrise; hence, the half-month will consist of 14 civil days and not 13. It is therefore quite clear that a 13-day half-month is never possible if mean motions are adopted and the fact that reference of such a half-month occurs in the above lines, leads one to infer that the Indians knew how to calculate true positions of planets even so early as in the *Mahābhārata* age; and this is a very important thing to note. Some one is likely to raise a doubt that the reference of a 13-day half-month in the *Mahābhārata* is an actual phenomenon recorded by actually counting the number of civil days elapsed between one lunation to the other after seeing the moon's position in the sky every night and not as a result of calculations based on mean or true motions of planets. This is simply an impossibility. A 13-day half-month is possible (as is shown above) only when the ending moments of new or full moons are about a few ghatis before or after sunrise. The moon is never visible on a new moon day, and it is doubtful if it is visible when the ending moments occur near about sunrise. A calm consideration of the problem will convince one that the possibility of such a missing half-month is noticeable not by observation of moon's position by actual mathematical calculation. It is difficult to explain the thing more clearly and in shorter terms.

The above references show that the lunar eclipse had fallen on the Kārtiki full moon day and solar eclipse on the next following new moon day. Now, when a 13-day half-month is the light half of a month, the beginning eclipse must be solar and the ending one a lunar as can be seen from such a half-month viz. *Vaiśākha Śukla pakṣa* of current year (i.e. Śaka 1817). But, if a 13-day half-month is to be taken as a dark half of a month, the falling of a lunar eclipse in the beginning and that of a solar eclipse at the end is an impossibility. One will not find such an example in any of the past almanacs. Even if it be supposed that such a half-month did occur, maximum length of it would be 13 days 30 ghatis; but the max-length of actual any 13 consecutive civil days can never be less than 13 days 50 ghatis. According to modern accurate

[illegible]

It is probable that occurrence of a 13-day half-month and that of a solar eclipse are exaggerations. Even then we can not say that the phenomenon of the occurrence of a 13-day half-month was not known to people in those times, and the above discussion does not come in the way of our inference.

Now let us see what references we get about planets in the Mahābhārata. One comes across the following lines in a passage describing the god Sun :—

• 3 •

॥ नमो भगवते वासुदेवाय ॥ १ ॥

मन्त्रमन्त्रेण तन्त्रम्, मन्त्रं मन्त्रं वृत्तिं ॥२०॥ श्रीगणेशाय नमः ॥ अ. ३७.
निःसर्गो भगवन् सर्वमन्त्रमन्त्रः ॥२१॥ श्रीगणेशाय नमः ॥ अ. ३७.

lying these phenomena.

R. V. Vaidya

Many people try to suggest that the current names of some planets which occur in Indian astronomy are not originally Indian but of foreign origin, but their names as given by the Mahābhārata are strictly of Sanskrit in origin.

Retrograde Motion of Planets

References about planets' retrograde motion occur at good many places;

e.g. see the following verses.

लोकात्तमं कर्तारं [शुक्रो] विमोक्ष्य पुरीष ॥२॥

भाष्य. अ. १८.

प्रत्यक्षं पृथिव्यात् सप्तर्षिः ॥ ११॥ ॥ अतिप्रसङ्गोऽयं ॥ ११॥

भाष्य. अ. २०.

तदा दृश्यः सदा तदा दृश्यः ॥ १२॥ ॥ अथ सप्तर्षिः पृथिव्यात् ॥ १२॥

भाष्य. अ. ११.

Planetary Conjunctions

We come across references of planets' mutual fights i.e. their conjunctions at many places; e.g. see the verses.

ततः सप्तर्षिः शुक्रोऽपि सप्तर्षिः [शुक्रोऽपि] ॥ ११॥

भाष्य. अ. १८.

शुक्रोऽपि सप्तर्षिः ॥ १२॥

भाष्य. अ. ११.

Positions of Planets at the Time of Bhārata Battle

The author gives below the positions of planets as described by the Mahābhārata. These refer to a period two months prior to the commencement of the battle or even the fighting period. When Lord Kṛṣṇa, who had gone to Kauravas on or about Kārtika Sūkta 12 for mediation, returned from his mission, on the 7th day before next new moon, he was met by Karna who says to him:—

पृथिव्यां हि मया दृष्टीनां मण्डपः ॥ ११॥ ॥ अथ सप्तर्षिः ॥ ११॥

शुक्रोऽपि सप्तर्षिः ॥ १२॥ ॥ अथ सप्तर्षिः ॥ १२॥

पृथिव्यां हि मया दृष्टीनां मण्डपः ॥ ११॥ ॥ अथ सप्तर्षिः ॥ ११॥

भाष्य. अ. ११.

These verses describe Karna's views about indications of bad omens and loss of general life on a large scale. Similarly, sage Vyāsa is describing in Chapter 3 of *Bhishma Parva*, planetary positions which give indications of wholesale destruction of public life. See verses 12 to 18 and 27.

पृथिव्यां हि मया दृष्टीनां मण्डपः ॥ ११॥ ॥ अथ सप्तर्षिः ॥ ११॥

शुक्रोऽपि सप्तर्षिः ॥ १२॥ ॥ अथ सप्तर्षिः ॥ १२॥

भाष्य. अ. ११.

पृथिव्यां हि मया दृष्टीनां मण्डपः ॥ ११॥ ॥ अथ सप्तर्षिः ॥ ११॥

शुक्रोऽपि सप्तर्षिः ॥ १२॥ ॥ अथ सप्तर्षिः ॥ १२॥

पृथिव्यां हि मया दृष्टीनां मण्डपः ॥ ११॥ ॥ अथ सप्तर्षिः ॥ ११॥

Famous astronomer Aryabhata (Saka 421) has stated in definite terms that the Bharata battle was fought in the ending period of Dvāpara (See description of Aryabhata, Part II) and it can be proved from his work that 3179 years of Kali had elapsed at the beginning of Saka era.

Varāhamihira (Saka 427) says,

अथर्वयुगं युगः सप्तमि युगं युगैरेतं युगं ॥
 षष्ठियुगं (२५२६) युगः सप्तमस्तत्र तमसः ॥

अथर्वयुगं, सप्तमि युगं.

"The sages (i.e. Saptarṣi stars) occupied the Maghā constellation when the King Yudhiṣṭhira ruled the earth; the year of his reign can be obtained by adding 2526 years to the number of Saka years elapsed."

This shows that according to Varāhamihira, Paṇḍavas lived 2526 years before Saka era i.e. after 653 Kali-years had elapsed; and he has described the movement of Saptarṣi according to Viddha Garga's opinion.

The sage Viddha Garga also appears to hold the same view. The history of Kashmir, by name Rāja Taraṅgini, has been written by Kalhana, who lived 700 years after Varāhamihira. He has also given in the first chapter (Ullāsa) the time of Paṇḍavas as 653 Kali-elapsed.

This time quoted by Garga and Varāha is simply an imaginary one. Varāha has stated in the chapter on Saptarṣicakra that these seven stars have motion and they stay in each nakṣatra for 100 years, and the Paṇḍavas' time has been calculated on this basis; but it is a fact that the Great Bear is almost stationary and is still on the meridian passing through Maghā just as it did in Yudhiṣṭhira's time. Hence if, the supposition that the 7-stars remain in each nakṣatra for 100 years be regarded as true, then Yudhiṣṭhira will have to be taken as having lived 2700 years or 5400 years (or some other multiple of 2700 years) ago from now. But, the stars have no motion, and hence the time calculated on this assumption has no meaning and so also the time given by Garga and Varāha is meaningless. This sage Garga flourished a century or two after Saka era started. He noticed the Great Bear to be on a meridian passing near about the constellation of Maghā and hence he must have decided that 2526 years before Saka elapsed after Yudhiṣṭhira lived. This big constellation occupies an extensive region of the sky and the stars could be said to be on a meridian passing through any of the constellations, Maghā to Citra. The same was their position in Garga-Varāha's time. (If some would tell the author that the Saptarṣis were formerly seen in the 'lune' occupying Maghā and if he thinks them to be in a 'lune' occupying 'Pūrva', he would naturally be led to believe that the Saptarṣis have got motion). Varāhamihira lived only a few centuries (two or three hundred years) after Garga; hence he also believed as true what Garga stated. In any case the time is imaginary.

The Mahābhārata states that Paṇḍavas lived at the end of Dvāparayuga, and this view was considered as correct even up to Varāha's time. Aryabhata I, who lived before Varāha (or was just his contemporary) accepts this view, but astronomers like Varāha and Garga do not; this leads one to feel that the Mahābhārata's statement is unreliable.

Shri Visaji Raghunath Lele has published in a news-paper in Saka 180 his findings about Paṇḍavas' time based on the planetary positions given in the Mahābhārata. Let us examine the case.

The summary of what Mr. Lele means to say is as follows :—
The dialogue between Karpā and Vyāsa shows some planets to be positioned on two nakṣatras each. Moon also is stated to be seen with two nakṣatras. The moon's position on the first day of fight is stated in the following verse.

पृथिव्याः शिखरं गच्छन् ॥ २ ॥

शिवः. अ. १७.

When Balarama returned from pilgrimage, it was the 18th day of the battle-

He remarked

यस्मिन् दिने कर्पः पृथिव्याः शिखरं गच्छन् ॥ २ ॥

This shows that the nakṣatra on the first day of the battle must have been either Rohiṇi or Mīṅā. Thus according to the Mahābhārata, the planetary positions were observed on two different nakṣatras as given below :—

Moon : situated in (i) Rohiṇi or Mīṅā and (ii) Māghā

Mars : " (i) Māghā and (ii) Anurādhā or Jyēṣṭhā

Jupiter : situated near (i) Viśākhā and in (ii) Śrāvāṇā

This shows that one nakṣatra seems to be 'divisional and Śāyana' and another one a 'stellar and nirayana.' These two nakṣatras, in each case differ by 7 or 8 nakṣatras. Calculating the possible age when so much difference in Śāyana and Nirayana nakṣatras could have happened, we get 5306th year before Śaka era (or 2127th year before Kali era). The battle appears to have been fought in the Śāyana month of Mārgaśīrṣa of that year. The planetary position described in the dialogue of Karpā and Vyāsa refers to the period of 22 days before this. The author calculated planets' places on the Kārtika new moon day by Keropant's planetary tables. This book has accepted the Śūrya Siddhānta's measure for a year. The moment of equinox according to this measure comes to be 12^h 27^m after mean sunrise on Saturday, the eleventh tithi of Caitra Śukla pakṣa of that year. The tropical true longitude of the sun comes to be 8° 25' 1" which shows that the Caitra is actually the Śāyana-Pauṣā ; and the ayanāṃśa for that year was 3° 4' 59". Adding this to Śāyana longitude of the planet we get its Nirayana place. The new moon of Nirayana Māghā is found to occur 313 days after the vernal equinox in that year. The Śāyana positions of planets, at 12^h 27^m after mean sunrise at Bombay, come to be as given below :—

| Planet. | Trop. long. | Śāyana Nakṣatra. | Nirayana Nakṣatra. |
|--|-------------|------------------|--------------------|
| Sun | 7 3 16 | Viśākhā | Satābhīṣak |
| Moon | 7 3 27 | Anurādhā | " |
| Mercury | 7 1 8 | Viśākhā | Dhāniṣṭhā |
| Venus | 7 21 1 | Jyēṣṭhā | P. Bhādrapada |
| Mars | 4 6 34 | Māghā | Anurādhā |
| Jupiter | 6 17 47 | Śvātī | Śrāvāṇā |
| Saturn | 6 1 8 | Citrā | U. Bhādrapada |
| Rāhu | 7 10 43 | Anurādhā | Satābhīṣak |
| The moon's approx. long. (on next full moon day) | | | |
| 18 | | Rohiṇi | P. Pūṣyami |

Mars is said to be in Maghā ; by calculation it appears to be Sāyana Maghā. Jupiter and Saturn are stated to be near about Viśākḥā ; and calculation shows Jupiter to be in Sāyana Svātī and Saturn in Sāyana Citrā. The nirayana system was not at all in vogue in Paṇḍavas' time. The position of a planet used to be given as "situated in such and such sāyana division and near such and such star"; and according to this system Mars was given to be near the fixed star Jyēsthā (Alpha Antares). The fixed stars were and even now are situated somewhere near about the nirayana divisional nakṣatra of that name. According to that system, the star Jyēsthā was situated in the nirayana Anurādhā division and Mars conjoined with the star. The statement "anḡarakāḥ jyēsthāyam vakram kṛtvā" of the verse should not be interpreted as the retrograde motion of Mars, but its motion "away from" the star Jyēsthā as far as the latitude was concerned. Jupiter has been said to be near Śravaṇa, so we find it near Śravaṇa star by calculation. The moon has been given to be near Rohiṇī and so we find her position by calculation. Its position near Maghā is confirmed by calculation which shows her to have been near Maghā-star in the nirayana Pūrva-Phalguni division. Venus proves to be near P. Bhādrapada as told by the Mahābhārata. The words "Rāhuḥ arkam upaiti" meaning "Rāhu comes near the Sun" is found to be true by calculation. In short, the planetary positions described by the Mahābhārata appear to be given in terms of Sāyana divisional nakṣatras and actual stars, and the year of battle comes to be 5306th year before Saka era. This is the gist of what Mr. Lele has published. The following are some serious objections against his statement:—

(1) Mr. Lele states that the planetary positions given by the Mahābhārata are Sāyana ; but they are not so. The zodiac in the present time is taken to commence from Aśvini; following the same principle, Mr. Lele has converted the positions of all planets with regard to the equinox, taking first nakṣatra from this as Aśvini. But whence does he get the rule of regarding first nakṣatra from equinox as Aśvini? Sāyana-Aśvini-nakṣatra is not a visible star. It is quite obvious that originally the divisional nakṣatras began to be known by the names of some visible stars ; and hence, the sāyana nakṣatra in which the equinox used to take place in the time of Paṇḍavas must have got the name of that star which was actually situated in the division. But Mr. Lele says that the nakṣatras in the time of the Mahābhārata were sāyana and commenced from Aśvini. These arguments would lead one to infer that the system of reckoning sāyana Aśvini as the first nakṣatra must have come into vogue at a time when the equinox used to occur near about Aśvini star. By calculation we find that the equinox used to take place near a star of Aricṭis group in between Saka 500 to 800 but the Paṇḍavas lived long before this period. Hence, according to Mr. Lele's view, the Sāyana-Aśvinyādi system was in vogue about 26000 (or an integral multiple of 26000) years before Saka era. But we do not come across names of nakṣatras as begun from Aśvini; we get references of the nakṣatra cycle beginning from Kṛttikā or from Dharmistha or even from Śravaṇa. Not only this, but in the Vedas we do not get a single reference of 'Aśvinyādi' system, even in the Vedāṅga-Jyotiṣa we do not read of 'Aśvinyādi' system, but of Dharmisthādi; and the list of controlling deities begins with Kṛttikā. In the Rīgveda we no doubt get a solitary reference of Aśvini being the first nakṣatra, but it has been shown on page 72 that the

*The Nirayana divisional nakṣatras, shown in the above table are not given by Mr. Lele ; it is the author who has noted them for a clear understanding of what he wanted to say by stating that such and such planet was near a particular star.

This stand could be proved as unjustified from many evidences. The positions of planets given by the Mahābhārata are, therefore, not sāyana and hence, the time calculated on the basis of that assumption is also not correct. In addition to the two major objections raised against the assumption viz. that the planetary positions described by the Mahābhārata are sāyana some more minor objections could be brought against it :—

(3) The Mahābhārata states that Jupiter and Saturn were seen near "Viśākha". Mr. Lele, after interpreting Viśākha as a "sāyana-divisional nakṣatra" has shown by calculation that Jupiter had occupied the sāyana Svātī division and Saturn the sāyana Citra division and on that account they could be said to be near Viśākha. Now, sāyana Viśākha is not a star but a division ; where, then, was the need of saying that "Jupiter and Saturn were found to be near Viśākha", when they were respectively in the Svātī and Citra divisions ? They could have been stated to be in these starry divisions in clear words.

(4) The planetary position when Karna was killed is given in verse No. 6 :—

उत्तरतः शरिरेण रजिष्ठा युक् चक्राक्षयं तस्मिन् ॥ ६ ॥

In this Jupiter has been stated to be stationary near Rohini which does not move. (i.e. Rohini is not regarded as sāyana).

(5) Saturn is stated to be 'afflicting' Rohini and also the Bhaga (i.e. Phal-guṇ) nakṣatra. Mr. Lele has not considered these statements. This reference can be interpreted as one planet while conjoining with one nakṣatra 'afflicts' another, and 'Suryaputa' can for the sake of satisfaction, be interpreted, not as Saturn, but as one of the comets in the solar system.

(6) Mr. Lele has not been able satisfactorily to explain how Mars (Pāvaka-prabha-lohitāṅga stated in the verse Vakṛānuvākṛam) was 'retrograde and then direct'. He is required to interpret it, not as Mars but as some comet. In short, the position of some planets stated to be on more than two nakṣatras can not be satisfactorily explained by regarding the nakṣatras as sāyana divisions.

(7) The nakṣatras, referred to in the verse "Maghānuvāṅgārako vakrah Sṛavāṇe ca Brhaspati" must both be of the same one system ; but Mr. Lele regards Maghā as sāyana and Sṛavāṇa as nirayana. It is also interesting to note that 'Maghā' has been used in plural. How can a sāyana division be expressed in plural form ?

(8) The planetary positions in the early morning of the day on which Salya was killed are described in the line

यज्ञोत्तरायणं शिवाम्बुमयम् ॥ १८ ॥

शुक्रश्च, अ. ११.

This verse states that Venus, Mars and Mercury were together on that day. Mr. Lele's calculations do not explain and support the statement.

(9) Mars is stated to be 'offering prayers' to Anurādhā after 'turning round Jyēṣṭhā'. The retrograde motion of Mars is clearly shown here. As the calculations did not prove the motion of Mars as retrograde, Mr. Lele was required to interpret the word 'vakra' as otherwise.

(10) Accepting Mr. Lele's ayanāntas as true, if we convert the tropical longitudes of planets into nirayana nakṣatras, we get the moon's position to be in P. Phalguni and not 'near Maghā' as stated in the Mahābhārata ; Mars

is found to be in nirayana Anurādhā; and Mr. Lele regards it to be 'near jyēṣṭhā' as stated by the Mahābhārata. He also states that in the Mahābhārata age the planetary positions were not given in terms of nirayana nakṣatras but near some stars. Let us, therefore, find out the stars near which the planets in the year 5306 before Śaka, actually were. If accepting the annual precessional motion to be 50" the tropical longitudes of stars for the abovementioned year be calculated we get the longitude of the junction star of P. Bhādrapada as 8° 13' 5". Venus was 22° to its west i.e. even west of star Satabhiṣak. Would it look well if we say that it was near P. Bhādrapada?

The longitude of jyēṣṭhā was 4° 29' 22" and Mars was 23° to its west that is near the star Viśākhā; how can it be said to be near jyēṣṭhā? Even taking for granted that the actual precessional motion was somewhat different from 50", and that the stars also have got some motion and that the planetary positions were not given in terms of celestial longitudes but in right ascensions, it will still be found that the actual positions of these two planets do not tally with those given by the Mahābhārata.

It is possible to find some other time which is a bit later or earlier than that suggested by Mr. Lele and then one will not be able to raise the last 2 or 3 objections against it; still other objections do stand. On the whole it can be said that the planetary positions described by the Mahābhārata are not given with reference to a dual (sāyana and nirayana) system, and that the time suggested by Mr. Lele is not correct*.

Late Shri Venkatesha Bapuji Ketkar interpreted the verse about Saptaṛṣis that the Yudhiṣṭhira era was in vogue for 2526 years before Vikrama Śaka and hence, he considered that the Paṇḍavas lived 2526+135=2661 years before Salivāhana Śaka. On this supposition he maintained that the Mahābhārata battle was fought in the months of Mārgaśīrṣa and Pauṣa of the 2662nd year before Śaka i.e. in the year 2585 B.C. from Nov. 8 to Nov. 25 of that year. Taking 1° 13' 57" as the ayanāṃśa he calculated nirayana positions of planets true for the morning of Thursday, Kārtika new moon day, with the help of Keropant's planetary tables, which are given below:—

| Planet | Position | Nakṣatra | Planet | Position | Nakṣatra |
|---------|----------|----------|--------|----------|----------|
| Sun | 7 24 0 | ... | Venus | 7 10 33 | Anurādhā |
| Mars | 3 8 30 | Puṣya | Saturn | 6 7 51 | Śvātī |
| Jupiter | 7 24 48 | jyēṣṭhā | Rāhu | 8 19 39 | ... |

Moon has been calculated for Friday, the Mārgaśīrṣa full moon day. It is found to occupy the Mṛga nakṣatra, the longitude being 1° 27' 30". He says that the position of Venus as described by the Mahābhārata in the line "sveto grahaḥ prajvalito jyēṣṭhamākranya tiṣṭhatī" is seen to be true by his calculated result. After showing by calculation that there were eclipses in the beginning and at the end of Mārgaśīrṣa, Mr. Ketkar says that Jayadratha was killed at the time of the second eclipse. This event and the planetary positions do not tally with those given in the Mahābhārata**.

*This should not be taken to mean that the sāyana-system is not acceptable to the author. He wants only to say that the planetary positions given by the Mahābhārata are not sāyana. That the sāyana system of position reckoning was acceptable to the Vedas will be shown in detail later on.

**For objections against Mr. Ketkar's calculations readers are requested to see the May and June 1884 issues of 'Indu Prakash' and 'Poone Vaidhava' papers.

3000 B.S. and not earlier than this.

Knowledge of Planetary Motions

When the Mahābhārata was compiled people were possessing reasonable amount of knowledge of planets' motion. The following verse is worth reading.

|| ה'תש"ח ||
 ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח || ה'תש"ח ||

श्रीनिवास, अ. ३०९, श्रीमद्व.

In this we find references of lapse of a year, a month, a half-month and of a day. The term 'lapse of a day' occurs in Vedāṅga Jyotiṣa. The lapse of a half-month occurs in the Mahābhārata at a second place, discussed about in pp. 114-115. In addition to these two, we get a reference of a lapse of a month and lapse of a year. A lapse of one year occurs after every 85 years. (See the Udaya-system and mean-Rāśi-system under 'examination of the topic of Samvatsara in Part II); but this presupposes the system of describing Jupiter's motion in relation to signs. The Mahābhārata does not contain either Rāśi-terms or the system of indicating planets' place with reference to a 12-part system of an eclipse. From this it appears that the system of fixing a name to a year from Jupiter's place found by mean-rāśi motion was not in vogue in the Mahābhārata's time. The 12-year cycle system is more ancient than this. It depends upon the heliacal rise and set of Jupiter. By following it the lapse of a Samvatsara occurs often. This might have been in vogue in the Mahābhārata's time. If it be supposed that the mean-rāśi system was then in vogue we will have to accept that people had accurate knowledge of Jupiter's mean motion. The 'lapsed month' which occurs in our time can not be accurately found without knowing exact true positions of the sun and the moon. The system of naming months after nakṣatras has been described in Part Two and according to it the lapse of a month does take place; this shows that the system was known in the Mahābhārata period. From the discussion on 'lapse of a half-month' made before, it will be seen that they did not have accurate knowledge of true motions of the sun and the moon; but if the rule of making a month, a half-month and a day missing be the same as at present, then we shall have to believe that people in the Mahābhārata time had complete accurate knowledge of the true motions of and of corrections to be applied to the sun and the moon as at present.

Miracles of Nature

In the Mahabharata we find at many places descriptions about comets and meteors. The following description of the sun as causing rain is worth noting:—

॥ २१ ॥ ॐ नमो भगवते वासुदेवाय ॥ ॐ नमो भगवते वासुदेवाय ॥

1. 1940

At some places we find the moon associated with the tides of ocean; we get allusions to show their conviction that the earth is round. The following

verse will show that people had observed that the other side of the moon is never visible :—

यत्ति विवर्तः पश्येत् पश्येत् यत्ति ॥ १०३ ॥

शतिका, अ. १०३ ॥

These references show that we find among the people a curiosity of finding causes of natural phenomena after observing the miracles on the earth and in the sky.

The Samhita Section

In the Mahābhārata we come across many references about suggestions to do or not to do certain things as per Muhurtas section of Samhita branch of astronomy. It has already been shown above that the planetary positions have been given in the Mahābhārata with a view to describing the probable effects of such positions.

यत्ति विवर्तः पश्येत् पश्येत् यत्ति ॥ १०३ ॥ यत्ति विवर्तः पश्येत् पश्येत् यत्ति ॥ १०३ ॥

This has been addressed to Dharmā by Bhīṣma. The starting for expedition on Puṣya nakṣatra has been described at many places as being very auspicious. At one place we find mention of a 'Bhaga' nakṣatra as auspicious for marriage. In the Vedas alone we find 'Bhaga' as the deity controlling Uttara Phalguni; otherwise we find her as controlling Pūrva Phalguni. But P. Phalguni has not been included in the list of nakṣatras devoted to celebration of marriages. The following line refers to Draupadi's marriage with Dharmarāja.

यत्ति विवर्तः पश्येत् पश्येत् यत्ति ॥ १०३ ॥

शतिका, अ. १०३ ॥

Because Puṣya is not regarded as a marriage-nakṣatra, Caturdharma, the commentator, defends the acceptance of this nakṣatra saying "By the word 'Puṣya' is to be understood that nakṣatra which causes nourishment and not the Puṣya nakṣatra". The author does not agree with the explanation. The next description will show that Draupadi was married to five Pāṇḍavas on five consecutive days; but in our present day list of marriage-nakṣatras we do not find any five nakṣatras which are consecutive in order.

Summary

Matters of astronomical interest occurring in the Mahābhārata have been so far discussed, some of which are of much importance. Even though the terms, Meṣa, Viṣa, etc. and the names of week-days are not found in the Mahābhārata, it need not be suspected that these have been borrowed from the Greeks. The author reiterates them as follows :—(1) People had knowledge about planets at the time of Pāṇḍavas, whatever that time may be. No one thinks it was later than 1500 B.S. In any case, it was the time before names of 7 days and names of signs came into use, that is, before our astronomy came in contact with the Greek system. (2) The ecliptic was divided into 12 parts with respect to the sun's position. (3) The reference of a 13-day half-month shows that people had a working knowledge of finding the true positions of

One can not make definite statements about the above matters from references in the Pūrāṇas just as have been made from those in the Mahābhārata because one can not say with certainty anything about their time ; and to read through all Pūrāṇas is a matter of time and hence, the author does not make any observations about them. He has not considered anything about even the Rāmāyaṇa since it does not contain terms like Meṣa etc. It is, however, clear that some of its portions must be belonging to period later than the Vedic or Vedāṅga Jyotiṣa age and some of it must have been written earlier than the Mahābhārata's compilation ; but it is very difficult to make a definite selection of the two portions.

The Time of Satapatha Brahmana

Following lines are found in Satapatha Brahmana :—

२. ४. २. ४. २.

The statement "Kṛitika's never deviate from the east" implies that these stars always rise in the east, that is, they are situated on the Equator or the east but at a point north of east; this happens because of precessional motion of the equinox. Assuming 50" as annual motion, the time when the junction star of the Kṛitika's had zero declination, comes to be 3068 years before Saka and even 150 years earlier, i.e. the approximate time of commencement of Kali era, if 48" be adopted as the precessional annual motion. Calculating the declination of some other stars in this age, we find that the northernmost star of Rohini group, the southern three of Hastā group, two from Anurādhā, one from Jyēṣṭhā and one from Aśvini were situated near the Equator; only some one star from Hastā group (if at all) could possibly have been situated exactly on the Equator, otherwise none.

The statement about Kṛttikā's rising in the east is made in the present tense and they can not always do so because of precessional motion of equinoxes. In our time we find them rising to the north of east and they used to rise to its south in 3100 B.S. From this it can be inferred that the concerning portion in Satapatha Brāhmaṇa was written about 3100 years before Saka era.

The Time of Kṛttikādi system

The list of nakṣatras mentioned in the Vedas begins with Kṛttikā. The equinox used to occur in the 4th quarter of Bharanī division in the Vedāṅga-jyotiṣa age. It must have been in Kṛttikā before that time; and assuming that the nakṣatra-list commenced from Kṛttikā, Bentley and other European scholars have found 15th century B.C. as the time when the equinox used to take place in Kṛttikā; but this is erroneous. The mistake which was committed in the case of Vedāṅga-jyotiṣa has been committed in this case also. The tropical longitude of Kṛttikā must have been zero in the age when equinox used to coincide with this asterism. Its sâyana longitude in 1850 A.D. was $57^{\circ} 54'$. Hence, the time of equinox being in Kṛttikā comes to be $(57^{\circ} 54' \times 72) / (1850 - 2320)$ B.C. The scholar Bayo has found out the time of Kṛttikādi system as prevailing amongst the Chinese to be about 2357 B.C.* and he must have found the time by adopting the same system of calculation as followed by the author. He has not read Bayo's original articles; but it is surprising to see that Bayo has not followed the system in the case of Hindus which he has done in the case of the Chinese-nakṣatra system.

According to Weber, the time of Kṛttikā being first nakṣatra comes to be somewhere between 2780 to 1820 B.C. Dr. Thibaut has a fairly good knowledge of Indian astronomy. His opinion about this point has recently been published. The gist of his arguments is as follows:—There is no support to show that Kṛttikā was regarded as the first nakṣatra because equinox used to occur in that nakṣatra. We do not come across any description in the Vedic literature about planetary positions signifying a time prior to the one given by the solstitial positions described by Vedāṅga-jyotiṣa. The statement of winter solstice occurring in the beginning of Dharmisthā nakṣatra is very ambiguous; because the stars in the nakṣatra division** occupied by the sun is never visible; it can not be said with certainty at which point of the ecliptic the sun must have been for the occurrence of the winter solstice given by Vedāṅga-jyotiṣa. Hence, the time calculated by the above method is liable to be mistaken even by 1000 years.

The Europeans have not even now understood the quotation from Satapatha Brāhmaṇa given above. The Pleiades are seen above the horizon for about 10 or 11 months during the year; and when they used to rise exactly in the east, this eastern rise could be seen from any place on the earth then; and there is nothing to be doubted about this. If there would have been an error of 1 degree in ascertaining the exact astronomical east, that in the calculated time would not be more than 200 years. In short, the reason why Kṛttikā used to be reckoned as the 1st nakṣatra was their rising in the exact East. The time for this event was about 3000 B.S. without doubt.

The Vedic Age

The Taittiriya Sāṃhitā which is more ancient than Satapatha Brāhmaṇa also mentions Kṛttikā as the first nakṣatra. Hence, this part of the Sāṃhitā

*See translation of S.S. by Burgess.

**See the 1895, April issue of Indian Antiquary XXIV.

must have been compiled either in 3000 B.S. or a century or two before. The statement about Kṛtikās being first is unequivocally given in Śatapatha Brāhmaṇa and hence its time is definitely 3000 B.S. or a century or two later. It can be said without doubt that all those sections of the Vedas which quote Kṛtikās as the first nakṣatra must have been compiled a century or two earlier or later than 3000 B.S. The R̥gveda Saṃhitā does not mention the Kṛtikādi nakṣatra system ; hence, it must belong to a time earlier than 3000 B.S.

Who was the Originator of the Nakṣatra System ?

Some Europeans maintain that the Vedic nakṣatra system does not belong to the Indians originally. The author thinks there is no country in the world to the people of which (however savage they might be) never observed any association of the moon with the stars or have not given any names to them.

If no other evidence can be given to show that the Vedic nakṣatra system belongs to Indians, at least some of the Vedic stories, like the Moon's love to Rohiṇī, can be taken as sufficient evidences. The time when, according to some Europeans, the Hindus appear to have borrowed this system from the Chinese, the Babylonians or other unknown countries, could not have been earlier than 2780 B.C. ; but it has already been shown above that nakṣatras were known to Hindus earlier than 3000 B.C. and that these are mentioned in the Vedic literature even before this time. From this it will appear that the argument, that nakṣatras have been borrowed by Hindus from foreigners, does not stand. If Chinese have established their system independently, then the Hindus also have done the same independently and any impartial thinker will agree with this.

Caitra and Other Names

It has been observed that names of months, Caitra and others are nowhere found in the Vedas ; but they are found in later works of the Brāhmaṇic period. We come across the following line in Śatapatha Brāhmaṇa.

यस्यैतान्मासान्मासं चैतरेवमाह... अथैतान्मासान्मासं चैतरेवमाह ॥

श्रु. अ. ११. १. १. १. १.

"It is the new moon of Vaisākha.. which becomes a source of prosperity to us, to people and to beasts."

Śatapatha Brāhmaṇa consists of two parts comprising 14 sections in all. The first part, known as Pūva Śatapatha, contains 10 sections (= 66 chapters) and the second part, Uttara Śatapatha consists of 4 sections (= 34 chapters). The above line occurs in the 11th section ; just before this line we get the line

अथैतान्मासान्मासं चैतरेवमाह ॥

श्रु. अ. ११. १. १. १. १.

which means "do not lit fire on the nakṣatra", and it has been ordained in the first part that 'ādhaṇa' should take place specifically on the nakṣatra. We get a reference of the term 'Vedānta' at two or three places in the same portion of the 11th section in which the above line occurs and in which the portion of the Vedic literature known as 'Vedānta' containing Upanisads also occurs and the 14th section of Śatapatha Brāhmaṇa is devoted to the theory of Vedānta itself ; that it is known as Bṛhadāraṇyaka is also well known. It can easily be seen from this that the second part of Śatapatha Brāhmaṇa belongs to a

* A detailed discussion of precessional motion and of Layan system will be found in the second part. The consideration of such matters in this chapter are made on the assumption that the equinoctial point makes a revolution in about 26000 years.

We find the identity 'Caitra + Vaisākha = Vasanta (spring) season' in almost all works. The moment of commencement of season receded after a long time after the above identity became established in practice, and that is why we come across 'Mina + Mega = Vasanta' or 'Phalguna + Caitra = Spring' in some later works, and some almanac makers follow this identity at present. In our times the spring season is actually found to occur in Magha and Phalguna, but the definition 'Caitra + Vaisākha = Vasanta season' still persists in popular minds. The names Madhu and Mādhava have association with seasons and not with nakṣatras; still the long usage of the identity 'Caitra + Vaisākha = Spring' has made people wrongly to shift the association of Madhu from that of Spring season to the nakṣatra name and Caitra is now wrongly called as 'Madhumāsa'. When the time of commencement of spring receded from Caitra to Phalguna, the identity, 'Phalguna + Chaitra = Vasanta' came into use and we find this definition in some later works. But we do not find the identities 'Vaisākha + Jyēṣṭha = Vasanta' and 'Caitra as the second month of Śisira' in any of the older works, when it was a fact that, spring actually began one month earlier than Caitra (say, 2000 years before). This definitely points to the fact that the names Caitra etc. came into vogue in those times when the vernal equinox actually used to take place in Caitra; and this hint can lead one to find the probable time. The spring season commences one month before the sun comes to equinox i.e. when the tropical longitude of the sun is 330° ; and in order that the corresponding month should be named as Nityāṇa* Caitra, the longitude of Spica (Citṛā) must be less than this by 6 signs or 180° i.e. $330 - 180 = 150^\circ$. The tropical longitude of this star in 1850 A.D. was $6^\circ 21'$ i.e. 201° or in excess of 150° by 51° . The time for this advance $= 51 \times 72 = 3672$ years. Hence, the time for spring to occur in Caitra must be $3672 - 1850 = 1822$ B.C., and it can be inferred that the terms Caitra etc. must have come into vogue in this period. Now taking into consideration the fact that the spring season commences earlier in some provinces and later in others, the time when the terms Caitra etc. came into use will be taken to be earlier than what is found above. In some provinces the spring commences about a month and a half before the sun comes to vernal equinox and not earlier. Adopting the condition of "1½ month earlier than equinoctial day" the time of Caitradī system would come to be 2900 B.C. Again, the doubt as to when the spring season should be taken as begun, the different longitudinal values of nakṣatras, all these factors lead one to adopt 4000 B.S. as the uppermost limit for the possible year before which the terms Caitra etc. could not have come into vogue. The Vedāṅga Jyotiṣa contains Caitra etc. as the names of months; its time has been shown to be about the year 1400 B.S. The Taittirīya Sāmhitā does not contain these names and the time of completion of some of its parts has been shown to be about 3000 B.S. He who has understood the sacrificial procedure given by Taittirīya Sāmhitā and the units of time like seasons and months, will know that if these terms would have been in use in the time of Taittirīya Sāmhitā they must have entered the text at some place or the other. This argument will convince the reader that the terms were not current before the time 3000 B.S. There are several big volumes of Brāhmaṇic works (at least 4) which do not mention these terms. It is clear that these are of later date than Taittirīya Sāmhitā. After weighing all these facts the writer feels that the time when the names Caitra

* For the sake of convenience I call a solar month as āyana and the sidereal month as āyana.

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shown to be true from 'Agrahayani' being the name of Migastisa.

B.S. and some of the Vedic Sutras could have been possibly compiled then.

below:—

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VII

According to this by the word 'Phalgun' we have to understand the full moon night, the moon being conjoined with Phalguni nakṣatra. At present the Phalguṇa-month of the 'Pūrṇimānta' system ends on the Phalguni full moon day and Caitra begins on the next day. Similarly we find in the above lines, the Pūrva Phalguni full moon day being mentioned as the last day of the year, and the next night as the 'mouth' (commencing night) of the new year, and the 'adḥana' ceremony has been recommended for that day; and in the foregoing lines we find that 'adḥana' ceremony has been ordained to take place on the same day, it being the beginning day of the Spring season. All these lines are given in the same stanza and must be correlated. This proves that the Phalguni-full-moon day must have definite relation with Spring. The Āśvāyana Śrauta Sūtra gives, in relation to annual sacrifice, the line (1. 2. 14. 3.)

"Those who desire to commence yearly or half-yearly sacrifices should make use of the full moon day of Phalguna or Caitra."

And in *Āśvālayana Sūtra* the months of *Phālguna* and *Caitra* are related to *Sisira* and *Vasanta* respectively; and the *Hemanta* season is bound to commence with *W. S.*; but nowhere do we find any relation of *Phālguna* with *Hemanta*. In some provinces the spring season is taken to begin even two months before the sun comes to the equinox; and on this basis, the commencement of spring with *Caitra* *Pūrṇimā* must be taken to happen about 4000 B. C., and the spring season can be seen to take place in the same particular month for 2000 years and hence the commencement of spring with *Phālgunī* *Pūrṇimā* must be taking place about 2000 B. C. and the idea of introducing the system of commencing the year at this very moment could have struck people's mind and no discrepancy is so far noticed in our reasoning. The *Viṣṇu* day used to occupy the central place in the *Samvatsara-Sātra* (annual sacrifice); but the word '*Viṣṇu*' does not appear necessarily to mean that day on which the day and night are of equal length. The year has been described as commencing on a full moon day; and once it is assumed that the central day should be one equinoctial day, it follows that the commencing day also must be another equinoctial day (within a limit of two days); and in order to satisfy this condition, it will be seen that the year cannot be made to begin on a full moon day. For, supposing a certain full moon day (being the commencing day of a year) was an equinoctial day; then the next equinoctial day would be the 11th day after the full moon day and the 3rd one, the 22nd day and so on. This shows that the word '*Viṣṇu*' used to mean in the beginning the 'central day of an annual sacrifice or of any other sacrifice' and this was particularly true about the *Taittiriya Sāphitī*; and as time went on, the term perhaps used to be applied to the equinoctial day and the year began on such day, and that is why the formula for finding out the *Viṣṇu* day has been given by *Vedāṅga Jyotiṣa*. Even according to Mr. *Tilak's* belief, the *Viṣṇu* day of 12 hours (30 *ghaṭī*s) length, does not occur in the middle of an annual sacrifice, but at the end of the 3rd and

9th months. It has been shown above, that there is no ground for any one to suspect that in the times when the stanza describing the annual sacrifice in the Taittiriya Samhitā was compiled, the Viṣvān (of the meaning of an equinox) used to occur in Phalguṇa.

The Limits of Vedic Age

The lower limit of the Vedic age can be roughly estimated on the basis of the fore-going discussion. But who would be able to fix up the upper limit? It can only be said that it can not be later than the year 6000 B.S. No one can say as to when the Vaidic mantras evolved in the human mind and in one sense the Vedas can be said to be 'Anādi' i.e. without a beginning. The lower limit of the Vedic age is about the year 1500 B.S. This is followed by Vedāṅga Jyotiṣa. The Samhitās (i.e. collections of mantras) of all the Vedas, Brāhmaṇas and some of the Upanisads have been compiled even during this period. Some Upanisads might have been compiled even during Vedāṅga Jyotiṣa period; but the lower limit of the Vedic age has already been given above. A part of the Rīgveda Samhitā belongs to 4000 B.S. The Taittiriya Samhitā belongs to 3000 B.S. The Brāhmaṇas were compiled between 3000 to 1500 B.S. Those of them which contain terms like 'Caitra and others' were compiled later than 2000 B.S., while others were compiled earlier. Nothing definite can be said about the Upanisads; but many of them were compiled between 2000 to 1500 B.S. It is not that the mantras of the Samhitā and Brāhmaṇas were compiled in the same time in the form in which they appear to us to-day, still it can be said that they emerged in their complete form before 1500 B.S.

Prof. Max Müller has thus attempted to fix up the period of the Vedic age:—"Lord Buddha attained 'Nirvāṇa' in the year 477 B.C. The Bauddha religion had its beginning about 100 years before this. The Vedic works were completely compiled till 600 B.C. They appear to belong to 3 periods—Sūtra, Brāhmaṇa and Mantra, the Sūtra period ranging from 600 to 800 B.C., the Brāhmaṇa period 800 to 1000 B.C.; and the Mantras of all Māṇḍalās (sections) of the Rīgveda were compiled in an earlier period." It is his opinion* that no human being will be able to say whether the Rīgveda Sūtras were compiled in 1000, 1500, 2000 or 3000 years B.C. and Europeans accept this view. These inferences are based only on history and philology. Taking into consideration this fact and also the assumption of a period of only 200 years for each Vedic subperiod, the author feels that the limits fixed above, on the basis of astronomical evidences should be accepted as correct.

The Limits of Vedāṅga Period

1500 B. S. is the upper limit of the Vedāṅgas. The lower limit can be fixed up after examining the problem as to when the 7 week days and Megādi signs came into vogue. The names of seven week days are not found in the Vedic literature. Of the remaining ancient works, references of week days are found in none except in Atharva Jyotiṣa and Yājñavalkya Smṛti; and references to Megā and others are found in none other than Baudhāyana Sūtra. It is needless to say that both are mentioned in Sūrya Siddhānta and other such works. Even if it be supposed that both of them are products of Indian mind, they, at least, did not belong to the Vedic period.

The order of names for the 7 week-days is as follows :

If the planets be regarded as revolving round the earth, they can be written in their order as Saturn, Jupiter, Mars, Sun, Venus, Mercury and Moon. It is assumed that the day is divided into 24 hours (Horā) and these horās are controlled by these seven planets in this very order. These planets get the lordship of the horās thrice in a day and 3 more horās remain. Hence, the lordship of the 1st horā at sunrise passes on to the 4th planet. If, for example, the lord of the first hour on the first day be Saturn (then last 3 hours will be controlled by Saturn, Jupiter & Mars) and Sun will be the lord of the first hour on the next day; and following the convention that Lord of the first hour to be reckoned as the lord of the whole day, if Saturn be the Lord of the first day, the Sun becomes Lord of the second and hence, Saturday is followed by Sunday. Thus we get the usual order of names of week days. It should be noted that the next day bears the name of every 4th planet from the previous one. The *Sūrya Siddhānta* observes as follows about it : —

शुक्रः शनिश्च मङ्गलः बुधश्चैव ।
गुरुश्च सूर्यश्च शक्रश्चैव ॥७८॥

"The Lords of days are to be reckoned in order fourth from Saturn downwards. The lords of hours also are to be reckoned commencing from Saturn downwards." Even *Āryabhaṭa* says that the lords of days are to be taken as '4th from the previous one' "*Siṅghra Kramāt catvriṭhāḥ dinapāḥ*" (Kāl Kri. 16).

The system of dividing a day into 24 parts called 'horā' is true only in consideration with the theory of week days and astrology. The astronomical works, *Siddhāntas*, do enumerate time-units but they do not mention 'horā' as one of them, and no work belonging to Vedic and Vedaṅga period ever mentions it. This word is not Sanskrit in origin. *Varāha-mihira* has attempted to justify its Sanskrit origin by explaining that the word is 'coined' by taking the middle portion of the word *Ahorātra*, leaving out 'A' and 'Tra', but this explanation is not satisfactory. The Chaldeans had this unit in use since a long time and they did have a week of seven days as at present. Considering this the author feels that 'Week-days' do not belong to us but have been borrowed from Chaldeans.

It has been shown under the topics of Vedaṅga Jyotiṣa and the *Mahābhārata* that the terms *Mega* and others are Sanskrit and it can not be said for certain that the system of dividing the eclipsic into 12 parts did not originally belong to us. Even from Vedic works we find that people did conceive the idea of giving to asterisms names similar to some well known shapes. We can not, therefore, say for certain that the *Mega* signs are not ours. These terms, however, do not belong to Vedic or Vedaṅga Jyotiṣa period, which means that these were not in use before 1500 B.S. Now looking to the history of other nations, some say that these were known to Egyptians before 2160 B.C. and according to others even before 3285 B.C. Some are of opinion that Chaldeans knew both *Vara* and *Rāsis* before 3800 B.C. In any case, it can be said for certain that both these nations knew the terms before 1000 B.C. and Mr. Lajng writes emphatically that the 'Varas' were known to Chaldeans long before 3800 B.C.*

* See Proctor Lockart's English book "Nineteenth Century" and his article in the July 1892 issue, page 34; also see S. Lajng's *Human Origins*, Chap. V, pp. 144-158.

It can be seen from Vedāṅga Jyotiṣa that both of these were unknown in our country before 1500 B.S.

It is a matter of controversy if the terms Meṣa and others originated with shapes of clusters of stars. There does not appear to be any relation between their shape and name, irrespective of the consideration whether these belonged to Indians or have been borrowed. We do not get the form of a ram (Meṣa) from the clusters of stars of Aśvini, Bharani and begins from Aśvini. Meṣa happens to be first in order of signs and begins from Aśvini. Just as we have a definite reference of a Kṛttikādi system having been in vogue before the Aśvinyādi system, we do not find any reference by which it can be said that the order of Rāśis began from a sign other than Meṣa or the Meṣa sign began from a nakṣatra other than Aśvini; and there is no doubt that these terms were not current in the Vedāṅga period. Hence, it can be easily inferred that these terms came into vogue at a time when the vernal equinox occurred in Aśvini nakṣatra and Meṣa sign simultaneously. The tropical longitude of the star Beta Arietis was $31^{\circ} 53'$ and that of Alpha Arietis $35^{\circ} 34'$ in 1850 A.D. Hence, the years when the longitudes of these stars were zero come to be $31^{\circ} 53' \times 72 (= 2296) - 1850 = 446$ B. C. and $35^{\circ} 34' \times 72 (= 2561) - 1850 = 711$ B. C. It is, therefore, impossible that the terms Meṣa etc. were known in our country before these dates, the mean of these dates being 579 B. C. Another important fact is that the time when Śravaṇādi system described by the Mahābhārata came in vogue, has been proved to be about 450 B.C. (See page 110), and the Mahābhārata does not contain any reference about Meṣādi terms; hence, it can be safely inferred that these terms were unknown in our country before 500 B. S. It will be shown in Part Two that some of the Siddhāntic works like the old Surya-Siddhānta do not belong to a date later than 200 B. C. They do contain the terms Meṣa and others; similarly it can be proved beyond doubt that some of the astronomical (Siddhānta) works were compiled earlier than this date. All these considerations lead one to infer that the Meṣādi terms were introduced in our country about 500 B.S. and the week-day names came into use 500 years before this date. It has already been pointed out that suggesting a system of Rāśis (Meṣa and others) and of week days is not a matter of much importance; what is very important is the calculation of actual positions and motions of planets (See page 108).

In short, the lower limit of the Vedāṅga period comes to be 500 B.S. All those original works which contain the Caitrādi terms but neither the Vāra or Rāśi names, must be taken to belong to the Vedāṅga period, since these two must have got entry into them, had these been current in Vedāṅga Jyotiṣa period. The works on astronomy and religion belong to this category, and naturally the 'Kalpa Sūtras' and 'Smṛti's come to belong to this category. All works described in Part One, excepting Baudhāyana Sūtra, belong to the Vedāṅga period; and there is no harm if we say that, of these works, those which do not contain any reference of week days, were compiled earlier than 1000 B.S. The date of compilation of each particular work must be decided after considering the work independently. Fresh additions have been made in the text of the Mahābhārata from time to time till 500 B.S.; the matter of Śravaṇādi system lends a support to this view. Some more interpolations might have been made even after this date; but some portions of the work are very ancient. The astronomical description of the planetary positions definitely points to the age in which Pāṇḍavas lived. This is the author's view.

The lower limit of the Vedāṅga period is the upper limit of the Jyotiṣa Siddhānta period.

It is needless to say that the limits of the Vedic and the Vedāṅga age as fixed by the author are not very accurate. The ancient history and ancient literature are still matters of research and the above limits are likely to change when the research is made. The author is, however, certain that the lower limit for the Vedic period can not be later than 1500 B.S. and that of Vedāṅga period not later than 200 B.S.

IN VEDIC AGE THE YEAR WAS SEASONAL I.E. SOLAR.

The so far made discussion must have made it clear that excepting the last few centuries, the year was strictly seasonal or solar throughout the Vedic age. The months were lunar and adjustment to solar year used to be made by interpolating an intercalary month at a suitable place. We find in the Rk-Saṁhitā the names of seasons like Śarad, Hemanta etc. used in the sense of a year. This shows that one complete cycle of seasons formed the measure of a year and such a system of maintaining the measure of a year was followed in the Rīgveda Saṁhitā age. The lines like:—

ऋतुर्गृह्यतेः सप्तविंशति र्मासः

अ. अ. १. १८.

"A year can stand only with the help of seasons" indicates the same idea. The derived meaning of the word "Sampvasara" is "Sampvasanti itavaḥ yata" i.e. year is that period in which the seasons stand completely. These quotations clearly support the view that in Vedic times, by the term year was understood a period of one complete revolution of seasons.

Mādhva and Mādhava were the months of a year (Sampvasara). These indicate seasons. The importance of these months in the Yajurveda Saṁhitā and in all Brāhmaṇa works will be clear from the divine status which these months received. It will also be seen from the terms Āruṇa and others that they are associated with seasons and not with nakṣatras. The names of months current in the major portion of the Vedic age were Mādhva and others; the Caitrādi names got introduction in the last period of the age. These names got their association with the nakṣatras and hence, the year calculated on this basis must have been sideral. It appears from this, that the sideral year came into use about 2000 B.S., when the Caitrādi names associated with nakṣatras came into vogue; and before this time, people could carry on their affairs with Mādhva-Mādhava months and hence it is proved that the year was seasonal (i.e. tropical). Some people might argue that the Caitrādi names must have come into vogue not much later than the Mādhvādi name system. But it has been shown (pp. 30-31) that there were difficulties for the introduction of Caitrādi names after the nakṣatras got their names and that much time must have elapsed in between. Even without any other support it can be shown that the very fact that Mādhvādi names have a divine status in the Vedas and not the Caitrādi, is sufficient for one to infer that a number of centuries must have elapsed before Caitrādi names became current. The nakṣatras occupied by the sun is never visible; hence it is but natural that the seasonal year came into vogue earlier than the sideral year which is the interval between the sun's two consecutive coincidences with the same star. Now when the author says that the solar year came into use first and not the sideral one, it should not be taken to mean that a correct tropical year came into use after the actual difference between the lengths of the two years occurred.

known after studying the precessional motion of equinoxes. They in the Vedic age had the system of interpolating an intercalary month at the proper place so as to maintain the correct relation of lunar months with the seasons, so that the months of Madhva and Madhava would on average be found to occur in the spring season. Even when a 'fixed year' came into vogue in the latter part of the Vedic age, the year was to commence with W. S. as ordained by Vedāṅga Jyotiṣa, and other works recommended the commencement of a year with spring. From this, it is clear that their object was throughout that of following a seasonal year and they never dreamt that they are not following a tropical year system just as we in the present time do not suspect the change. Even if Mr. Tilak's argument be accepted that in Vedic times year commenced from W. S., the commencement of a year with a solstice is nothing else than following a seasonal year, and the year proves to be tropical and not a sidereal (or fixed) one. In short, we find that the seasonal year was in long use before the fixed year and from historical point of view the tropical year was acceptable to 'Srutis' and it was a natural one. Spring has been described as the 'mouth' of a year, Madhu and Madhava as months of the spring season and the Madhvadi names were current. All these things can not remain true without following a tropical year. The seasons will not be found to occur in the same months by following the nakṣatra-month-system, and an idea of their departure from the usual position is already given on page 132. From this it is proved that it was the tropical year which was acceptable to Srutis.

THE YUGA SYSTEM

Almost all aspects of the Yuga-system have been discussed in the preface. According to Aryabhata II, Mercury was behind the sun by about 9° in the beginning of the present Kaliyuga. According to the Surya-Siddhanta and Aryabhata I the longitude of the moon's Apogee was 90° and that of its Node 180°; but Brahmagupta and Aryabhata II quote different values for them.

While examining the works of the Manu Smṛiti and the Mahābhārata it has been shown that the measures of time units, yugas etc., as given by astronomical (Siddhanta) works, were already defined and fixed. These works are said to give as a criterion of the commencement of yuga the condition that all planets must come together in the beginning of Kaliyuga and of each other Yuga. (According to some other works all planets come to a close conjunction at the beginning of a Kalpa and come together within a reasonable proximity in that of a Mahayuga). This criterion or condition is neither found in these works or in any of the works discussed before. On the contrary we find in the Mahābhārata the condition for starting a Kṛtayuga, to be "the coming together of the sun, Jupiter, the moon and the Tisya (Pūṣya) star" (Vana Parva, 190.90/91). Similarly according to the astronomical works, the Kaliyuga started in the year 3179 B.S. But we do not find in any later works an explicit or implicit mention of this yuga having been so started. No reference to this age or to a criterion of the commencement is found in any of the Purāṇas and the above mentioned condition also is not well known.

The current year Saka 1817 is the 4996th year of Kali elapsed. It shows that so many years have elapsed after the commencement of the Kali era. This era, according to the Surya Siddhanta, commenced on Thursday at midnight when it was the mean Amāvasyā of Phalguṇa. According to some other Siddhantas it commenced after 15 ghatikas more, that is on Friday morning. Prof. Whitney has, in his translation of the Surya-Siddhanta in English

calculated mean positions of planets by accurate European formulae true for the midnight of Thursday, the 17th February 3102 B. C. (Julian period) which is the moment of commencement of Kali. The author has given in the following table these positions and also those calculated by him with the help of Astronomical Tables by Prof. Keroport Chhatre. These tables have been prepared by him with the help of European books on astronomy, and Prof. Whitney has calculated the figures with the help of these European books. The true places of planets at the beginning of Kali as calculated by the Surya Siddhanta formulae are also given in a separate column. The author has also given in another column planets' true places, the calculations of which have been based on Whitney's mean places, and taking nodes and perihelions from Keroport's tables. The European tables are proved to be very accurate in modern times and their calculations are verifiable by actual observations of planets in the sky. If these tables are followed, the positions of planets 5000 years ago must be found to be tolerably accurate, if not quite correct.

Places of planets in the beginning of Kali

| Sâyana mean longitudes | | | | True positions | | | |
|-------------------------------|--------------|----------------|--------------|------------------------------|--------------|--------------|--------------|
| According to Whitney | | | | European (Sâyana) | | | |
| According to Chhatre's tables | | | | According to Surya Siddhanta | | | |
| Sun | Moon | Moon's Perigee | Moon's Node | Mercury | Venus | Mars | Jupiter |
| 301° 45' 43" | 308° 03' 50" | 44° 56' 42" | 148° 02' 16" | 268° 34' 05" | 234° 36' 30" | 289° 48' 05" | 318° 16' 07" |
| 301° 13' 42" | 301° 36' 18" | 67° 32' 42" | 145° 00' 00" | 267° 36' 42" | 333° 45' 24" | 289° 11' 18" | 318° 04' 06" |
| 303° 35' 42" | 312° 15' 30" | | 147° 53' 34" | 288° 03' 54" | 316° 12' 06" | 300° 34' 18" | 317° 45' 54" |
| 2° 07' 27" | 5° 02' 46" | 90° 00' 00" | 180° 00' 00" | 358° 07' 27" | 0° 52' 12" | 5° 42' 30" | 0° 42' 00" |
| 281° 36' 18" | 280° 02' 18" | 278° 00' 18" | 353° 24' 57" | | | | |

The author has not applied the (what) time correction to the mean positions of planets calculated by him by Keroport's tables. Keroport has mentioned a "Kālanīar" [time] correction to be given only to the sun, moon, moon's perigee and moon's node. If it be applied to them they would agree with the places given by Whitney; and other planets, even when no "Kālanīar" (time) correction be given to them agree with Whitney's places. This shows that Whitney has not given this correction to the five planets, Mercury and others. The mean longitudes of all planets except Rāhu (moon's ascending node) are zero, according to the Surya Siddhanta. The European positions of planets are Sâyana and those of the S. S. are Nirayana. The measure of the error of our astronomical works is equal to the excess or deficit of the difference between Sâyana sun and any Sâyana planet and that between the longitudes of the sun and the corresponding planet according to the S. S.

We find that the sun's place according to Whitney is in advance of Mercury by about 33° and Venus is in advance of the sun by about 32°. If, therefore, the European tables are correct the error in the mean places of planets calculated according to our works should be taken to be equal to the planetary differences.

The planets in the sky are observed to occupy the calculated true places and not their mean places. A glance at the places calculated by European tables shows that the maximum distance between the sun and other planet is that of Saturn (25°) behind and of Jupiter (14°) in advance. According to the *Sūrya Siddhānta* all planets are within 9 degrees of the sun and are therefore 'invisible' and there appears to have occurred a solar eclipse on Thursday, it being an *Amāvasyā* day. According to European calculation only Mars seems to be invisible in the sun's rays. If Rahu's figure, according to Whitney, were taken 15° less, then there is a solar eclipse. Taking the longitude of Mercury 10° more, of Venus 9° less, of Jupiter 4° less and that of Saturn by 11° more, we get the following figures for true places of planets, showing that all planets are heliacally set :—

| | | | | | | | |
|---------|------|-----|-----|---------|------|-----|-----|
| Sun | 303° | 35' | 42" | Jupiter | 315° | 06' | 36" |
| Mercury | 290° | 40' | 06" | Saturn | 288° | 17' | 30" |
| Venus | 312° | 28' | 48" | | | | |

In brief, according to our astronomical works, all planets were together in the beginning of Kaliyuga, but the fact is otherwise. It may be that all planets were heliacally set, but we do not get even such a description in the *Mahābhārata* and other works. At least 2600 years elapsed after Kaliyuga till the *Sūrya Siddhānta* and other works were compiled, and the Yuga system described by the *Manu Smṛiti* was in vogue before these works; but it does not seem to have been proved that Kaliyuga actually started at such particular time. The quotation from the *Rig-Yajurveda* viz. "the herbs which grew in three yugas before" has already been given on page 12. The fact that Kaliyuga commenced in the year 3179 B. S. was established beyond doubt in the *Vedic* and *Vedāṅga Jyotiṣa* age, is not proved from this quotation. Hence, there are grounds for suspicion that the astronomers fixed up that moment as the beginning of Kaliyuga at which all planets were found to be together, starting backward calculation from the year of compilation of the astronomical work.

ROHINI ŚAKATA BHEDA

The Rohini constellation consists of 5 stars; these together form the shape of a cart and hence, the group of stars is known as 'Rohini Śakata'. Of these 5 stars the latitude of the northernmost star (Epsilon Tauri) is 2° 34' 43"S and that of the junction star is 5° 28' S; and when a planet while passing through this constellation possesses a latitude lying between the two figures, it is said to be piercing the 'cart'. The value of a planet's latitude depends upon its node. The moon's mode makes a complete revolution of the heavens in about 18 years during which the moon is able to pass through the constellation for 5 or 6 years only. It was pointed out on page 31 that the moon generally used to pass through Rohini constellation from September 1884 to March 1888. The conjunction of the moon with Rohini star has remained an object of interest since very ancient time. The story of the Moon's love with Rohini is very famous in the Purāṇas. The whole* paragraph No. 5 (in Chapter

* There is a detailed description of this conjunction (and translation of the paragraph also) given in chapter 'Rajani Vallabha' in the book "Jyotiṣa" (See page 52, second edition.)

3, 2nd Aṣṭaka of Taittiriya Saṃhitā) contains stories about the moon's special attachment with Rohiṇi, who was one of the 33 Prajāpati's daughters given in marriage to him. These 33 daughters are the 27 stars from 27 Nakṣatras and six stars from Kṛtikā group. It is evident that the story originated from the often observed conjunction of the moon with this star. This conjunction and its effects are described in detail in Garga and others' Saṃhitās; and we find that whole chapter No. 24 in Bṛhat Saṃhitā is devoted to the topic of "Moon's conjunction with Rohiṇi".

It is well known from the astronomical works that the piercing of the constellation of Rohiṇi by Saturn and Mars indicates disaster in the world. Varāha-mihira says,

विश्वविनाशकाले च सप्तमि रोहिणीयाम् ॥

सिद्धिर्वास्तु यदा सप्तमि रोहिणीयाम् ॥ ३५ ॥

सू. सं. ३४.

"If the Rohiṇi constellation is crossed through by Saturn, Mars or the Moon, I will not be surprised if the whole world completely plunges into the ocean of disaster and gets ruined."

Gaṇeśa Daivajña, the author of Graha Laghava, says,

विश्वविनाशकाले च सप्तमि रोहिणीयाम् ॥

सू. सं. ३३. १२.

"The piercing of Rohiṇi-cart by Saturn or Mars is a phenomenon rarely to occur after interval of yugas".

In the present times when Saturn approaches Rohiṇi, its maximum latitude becomes $1^{\circ} 50'$ South and that of Mars, about $12'$ North; hence, neither of them pierces the cart. Then how could descriptions of disasters due to their passing through the constellation get into astrological works? It is not that such a phenomenon is an impossibility. We know that Jupiter's south latitude never attains a value of $2^{\circ} 35'$, and we do not read of the piercing of Rohiṇi by Jupiter in the astrological works; but this is not the case with Saturn and Mars. The maximum value of Saturn's south latitude is $2^{\circ} 45'$, and that of Mars is $2^{\circ} 53'$. These planets, therefore, do come within the range of 'Rohiṇi cart', some time during the revolution of their nodes in the sky. These revolutions take about 40 to 50 thousand years and some time during this period, these planets must have passed through the constellation of Rohiṇi. While attempting to calculate possible years for Saturn the author finds that the crossings by these planets have never occurred after the commencement of Saka era; not only this, it never occurred during 5000 years before Saka era. He found that in the year 5294 B.S. the tropical longitude of the northernmost star of Rohiṇi was $10^{\circ} 28' 2''$ and when Saturn came to that position, its south latitude was $2^{\circ} 34'$. From this, it appears that near about this year and during a number of years before this, Saturn used to pierce the cart in each round. The time of piercing the cart by Mars appears to be much earlier. The Sāṃhitā works describe the effects of Sakābheda by Saturn and Mars and since this crossing did not occur later than 5000 years B.S., it is proved that people in India had acquired knowledge of planets and their motions 5000 years before Saka era.

* Calculations have been made from Prof. Chabre's 'Table of planetary calculation'. The details of calculation are not given here for want of space.

It is evident that people had acquired knowledge of stars even before this, and this lends a support to our views expressed about the times of the Vedic period and that of compilation of the Rk-Samhitā.

KṚTĪKĀDI SYSTEM

नक्षत्रः सप्त ॥ सप्तैव नक्षत्राणि ॥
 सप्तैव नक्षत्राणि ॥ सप्तैव नक्षत्राणि ॥
 सप्तैव नक्षत्राणि ॥ सप्तैव नक्षत्राणि ॥
 सप्तैव नक्षत्राणि ॥ सप्तैव नक्षत्राणि ॥
 सप्तैव नक्षत्राणि ॥ सप्तैव नक्षत्राणि ॥

"Kṛtikās are the first and Viśākha the last; these constitute Divine nakṣatras : Anurādhā is the first and Apabharaṇī the last; these constitute Yama nakṣatras : The divine stars turn from South (to North) and the Yama nakṣatras from North (to South)".

The bracketed words are not given in the original text; but Mādhaba-
 cārya, the commentator of the Vedas has rendered the word 'dakṣiṇa-
 as 'from south to north' in the following lines in the Taittirīya Samhitā
 (See Chapter on 'ayana' by Kāla Mādhaba).

नक्षत्राणि सप्तैव नक्षत्राणि ॥

स. म. १. ५. ३.

"The sun goes by the south for six months and for six months by the north."

The word 'dakṣiṇa' can mean 'to the south of a certain object'; but no mention of a second object has been made in the sentence. If the divine stars be taken to be situated to the south of the ecliptic and the others to its north, it is an impossibility; because, Kṛtikās lie to the north of the ecliptic, the next 3 constellations are situated to its south, and the next 2 are again found to lie to the north; the stars are thus irregularly situated and the latitudes of the stars will never change (they might vary only by a minute or two of an arc in thousands of years). Hence, the description can not be said to be with reference to the ecliptic. Similarly it can not happen that all 'Kṛtikādi' groups be found to be situated to the south of the equator and others to the north. The declination of stars always changes due to the precession of equinoxes, i.e. their position, north or south of the equator changes. But because the latitudes of some stars like Arcturus (Svāt), Altair (Śravaṇa), Delphinī (Dhanīṣṭhā), Alpha-Andromeda. (Uttarabhadrapada) are greater than 24°, these stars will never be found to lie to the south of the equator*. Hence, none of 13 consecutive constellations will be found to lie to any one side of the equator. If an observer stands at any place on the earth, he will not find half the number of constellations moving from the northern side and half from the southern. Hence, the line 'dakṣiṇa part-yaṇī' can not be rendered as 'to the south of any particular object'. If we translate the above lines as "the Kṛtikādi stars move from South to North", the sum total of the argument becomes that these are found to be situated in the sun's path when it moves from south to north. This leads one to

* I have attempted to find the positions of stars in 2350 B.C., 1462 B.C., 570 A.D. and 1887 A.D., but I never found that 13 consecutive constellations were on the same side of the equator. The calculations can not be given for want of space.—Author.

accept that the winter solstice used to occur on Kṛtikā, and the time for the occurrence of the W. S. there comes to be 8750 B. C. But there are certain difficulties in translating the lines in this way. The Śatapatha Brāhmaṇa definitely quotes the position of Kṛtikā as "rising to the East". If the above meaning be taken to be correct, the difference in the times of Śatapatha and Taittirya Brāhmaṇas comes to be about 6000 years, which is not possible and since we get a definite reference of the W. S. occurring on Dhanishṭhas we should naturally expect to get references of the W. S. occurring on the intermediate 6 nakṣatras; but we do not get this in any of the ancient works. It is also true that the star-lore was known to our people in such an ancient period is not an impossibility, as can be seen from the discussion of the topic of "piercing of Rohini-cart". It is not still clear what these lines really mean.

THE BRIEF SUMMARY

So far has been described in detail the astronomical knowledge which people obtained during the Vedic and Vedāṅga Jyotiṣa periods. The association of Greek astronomy with that of Indian, if it was formed at all, belongs to the later period. The whole knowledge described in this part has been independently obtained by the people of our country. The author describes in brief some special information chiefly related to their knowledge of motions and positions of planets. Other important things can be referred to the places where they have already been discussed in detail.

People possessed knowledge about stars before 5000 B.S. The system of adding an intercalary month must have been introduced in those days. The months were lunar. They had obtained some knowledge about planets. This should not be taken to mean that they were able to predict planetary positions for the future. They found that planets have motion and they had begun to observe their positions with respect to stars. The months were then probably called by Mādhva, Mādhava etc. Caitra and other names of months came into vogue at about 2000 years B. S. and till that time the year used to be tropical. Later on, it became sidereal in form because of introduction of 'Cairādi' names for months, but in principle the year was no doubt tropical.

The time of Śatapatha Brāhmaṇa, from the references about Kṛtikā in it, comes to be 3000 B.S. and the Vedic Sāphita undoubtedly belongs to an earlier period.

The time of Vedāṅga Jyotiṣa has been proved to be about 1500 B.S. In those days, the measure of the day was 60 ghaṭikās. The mean motions of the sun and the moon were tolerably accurate. The measure of the solar year was erroneous; still, that kind of solar year was in vogue. Not only the system of adding an intercalary month to bring agreement of the lunar year to the solar one was in use, but the year was divided into 12 solar months. The concept of the system of the Eclipse being divided into 12 parts, each part being divided into 30 divisions, and each such division subdivided into 60 parts, had taken root during this period; and an important thing viz. introducing similar units for time divisions and area divisions came into practice. There are sufficient grounds to believe that the division of a circle into Rāśis, degrees, minutes and seconds is the result of Hindu-imagination. It seems that people had acquired knowledge of mean motions and positions of planets by the end of the Vedāṅga period.

The next important step is the knowledge of true positions and motions of planets. It has been shown under discussion on the topic of '13-day half-month' that people had acquired working knowledge of calculating true positions of the sun and the moon. It is more difficult to understand and calculate the true positions of planets than those of the sun and the moon. No definite proofs are known for the confirmation of this. But the fact that the retrograde and direct motions of planets used to be a topic of their discussion, leads one to believe that people had come to know that the true positions are not regular like the mean positions, and hence it can be conjectured that they had probably begun to deliberate upon the aspect of true motions of planets. We find a mention of solar months in the Vedāṅga Jyotiṣa period. From this it can be said that the system of dividing the ecliptic into 12 parts had come into vogue in the Vedāṅga Jyotiṣa period or very soon afterwards but the positions of planets are found to have been mentioned with respect to nakṣatras. This shows that the system of indicating planetary places in terms of 12 Rāśis had not come into vogue then.

The names of Rāśis (Meṣa and others) came into vogue at about 500 B.S. The names of week days came into use before then, and have been borrowed from foreign countries.

The system of reckoning a Mahāyuga as equivalent to 4320000 years must have come into vogue in a period earlier than Yāska.

The Atharva Jyotiṣa shows that astrology came into existence into our country quite independently.

In short, the origin of the knowledge of calculation of the true places of planets and that of predicting their effects (i.e. astrology) had taken root at the end of the Vedāṅga Jyotiṣa period. The process by which that knowledge gradually developed into the form of treatises will be discussed in detail in the second part.

